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SHAW (F. J. F.). **Report of the Imperial Mycologist.**—*Scient. Reports Agric. Res. Inst., Pusa*, 1920–21, pp. 34–40, 1921.

The cultural study of species of *Helminthosporium* on maize, 'jowar' (*Andropogon sorghum*), sugar-cane, rice, wheat, and barley was completed during the year under review. No perfect stage of any of them was discovered, but *H. teres* Sacc. on barley was observed to produce pycnidia and chlamydospores when grown on sterilized wheat straw; the latter have not been described hitherto. The species on maize and sorghum appear to be two different strains of *H. turcicum* Pass. From the results of cross-inoculation experiments it is concluded that there is no specialization of parasitism in these two strains, the fungus from one host being capable of infecting the other. They can also infect wheat, barley, oats, sugar-cane, and rice, but not *Pennisetum typhoideum*. Four cultural strains from wheat gave positive results when inoculated on maize, sorghum, oats, barley, rice, and sugar-cane, and the forms isolated from rice and sugar-cane infected all these as well as wheat. *H. teres* Sacc. from barley attacked maize, sorghum, wheat, oats, and rice. Hence it would seem that there is no specialization in these forms. *H. gramineum* Rabenh., the cause of stripe disease of barley, can be very destructive, a serious outbreak occurring during the year on a plot of 'Cape' barley; other varieties in neighbouring plots appeared to resist the disease, though cross-inoculation gave positive results. The species on barley and oats do a great deal of damage to the seedlings and young plants.

*Acrothecium lunatum* Wakker has been found on *Setaria italica, Panicum frumentaceum, Eleusine coracana*, and many other plants; it appears to be a weak parasite which produces small spots. A study of another species of this genus, *A. penniseti* n. sp., was published by Mitra [see this *Review*, i, 4, p. 103].

The work on chilli (*Capsicum*) diseases was continued, a paper on the die-back disease being published by Dastur in 1921, besides two other papers published in 1920. Diseases of jute are also being investigated, Shaw having published an account of that due to *Diplodia corchori* [see this *Review*, i, 1, p. 20].

*Urocystis coralloides* Rostrup, a rare smut on mustard (Brassica), was discovered for the first time in India in the vicinity of Pusa. An account of the species of *Cerebella* in India has been prepared by Subramaniam.

Experiments were carried out with a view to testing the efficacy of a spray for destroying water hyacinth (*Eichornia crassipes*), the spray used being a secret proprietary mixture which has given satisfactory results in other parts of the world in the eradication of the prickly pear. The results indicated that the spray effectively killed the water hyacinth, that it was non-poisonous to live-stock, that it could be easily applied by means of a sprayer of the usual type, and that rain did not interfere with its efficiency. One gallon of the spray was found to be sufficient to destroy 24 to 30 sq. yds. of water hyacinth, and this area could probably be doubled with more efficient machinery; the inventor states that the fluid costs 0·3 penny per gallon, and the cost of material would thus be 5 to 6 shillings per acre at the most.

BRYCE (G.). **Report on the work of the Botanical and Mycological Division.**—*Rept. Dept. of Agric. Ceylon, 1920*, pp. 13–15, 1921.

The following notes refer to the diseases of plants.

RUBBER. Brown bast has decreased in prevalence during the year. The writer thinks that its actual cause is still obscure, but notes that it is less severe in Ceylon than in countries where more severe tapping of the tree is customary. The morbid anatomy of the affected tissues has not yet been fully elucidated, but the condition will probably be found to be closely related in its inception to the alteration of latex vessel content preceding nodule formation, the latter being a normal feature of the disease. The root diseases due to *Fomes lignosus* and *F. lamaoensis* are still causing much loss, and the importance of removing old jungle stumps in order to check their development is again emphasized. Attacks of *Ustulina zonata* on the stem are also frequently due to neglect in removing old logs, on which it is often found fructifying. Decays of renewing bark have been less serious than in earlier years, preventive painting with Brunolinum and the like having an undoubted effect in reducing this group of diseases. Leaf fall and pod disease due to *Phytophthora faberi* and *P. meadii* have also been less frequent, probably owing to the late arrival of the monsoon rains. Fructifications of *Fomes lucidus* were twice found on Hevea, apparently occurring saprophytically, but there is a possibility that it may be a wound parasite. A species of *Meliola*, growing on the secretions of scale insects, was fairly common on the leaves, but the damage caused by it is negligible. A diseased condition of the leaf-petiole was recorded; local swelling of the tissues was succeeded by rupture, which formed a canker. A certain amount of leaf fall was caused, but no parasite was detected.

TEA. Red rust (*Cephaleuros*) was present in certain districts; it is apparently associated with an enfeebled condition of the bushes, due to shallow soil or unfavourable climatic influences. *Poria hypolateritia* continued to be a serious disease, spreading freely through the soil and very difficult to eradicate. A new branch canker caused by *Helminthosporium gigasporum* B. and Br. was

recorded. The bark was killed back from the pruning cut, usually on the upper side of the branch. In conjunction with this a canker, closely resembling that caused by *Leptosphaeria*, was found, but no fungus was isolated. Severe damage was caused in one instance. Two ascomycetous lichens, *Trypethelium megaspermum* Mont. and *Verrucaria santensis* Tuck. are reported to cause stem galls of tea seed-bearers. In the first case the lichen fungus penetrates the cortex and ruptures the tissue along the line of the cork cambium. Its presence stimulates the branch to excessive growth, and a large woody swelling appears on the stem, covered by a thick, wrinkled, and warted layer of abnormal cortex containing the fructifications of the fungus. The effects of penetration by *Verrucaria santensis* are similar but less marked. The stems of seed-bearers should be covered with lime, to which both the lichens seem very susceptible. Experiments were carried out to test the efficacy of formaldehyde as a disinfectant of imported tea-seed. Its value was found to be considerable, though it has the defect of a low power of penetration in seed spread on superimposed shelves.

COCO-NUTS. *Phytophthora* nut fall occurred to much the same extent as last year. Spraying with Bordeaux mixture may prove effective in checking this disease. Leaf drop due to *Phytophthora* was less frequent. Leaf break or die-back of coco-nut leaves was found to be associated with a species of *Diplodia*, the spores of which are smaller than those of *Botryodiplodia theobromae* and remain white for a longer period. 'Tapering of the crown', a diseased condition of coco-nut stems involving rapid dwindling in diameter and barrenness of the palm, has been partially investigated. It is evidently related to the condition known in Jamaica as 'pencil point'. Field observations show that many dead roots occur mingled with the vigorously growing ones. *Sphaeronema* sp. and *Pestalozzia* sp. were isolated from dead roots, but the condition, though believed to be a root disease, cannot with certainty be ascribed to the action of these fungi.

GREEN MANURES. *Poria hypobrunnea* was again recorded as a serious root disease of dadaps and *Tephrosia candida*. *Irpex subvinosus* causes a stem disease of the latter.

FOOD CROPS. *Piricularia oryzae* was recorded on rice, but the commonest diseases of this crop in Ceylon are those due to *Sclerotium* and *Helminthosporium*. Rice seedlings at the Peradeniya Experiment Station were badly attacked by a *Fusarium*. The point of attack was the micropyle, where pink acervuli were formed. The young shoots of the germinated seeds were coated with mycelium, but the shoots above four inches in height appeared to be immune. The most susceptible varieties were Macan Pina from Manila, and Hatiel. *Phoma glumarum* was also recorded on rice. Maize was attacked by *Puccinia maydis*. A disease of bananas at Uda Hewaheta was found to be due to the planting of suckers infested by the root-boring beetle. This resulted in the dwarfing of the new suckers.

MISCELLANEOUS. *Mycosphaerella caricae* Sydow and *Colletotrichum caricae* Stevens & Hall were recorded on *Carica papaya*. Other new records are *Puccinia nakanishikii* Diet. on *Andropogon citratus*, *Kordyana commelinae* Petch on *Commelina nudiflora*,

and *Melampsorella ricini* (Biv.-Bern.) de Toni on castor-oil plant.

SMITH (E. F.). **Effect of crown gall inoculations on Bryophyllum.**—*Journ. Agric. Res.*, xxi, 8, pp. 593–597, 10 pl., 1921.

The author, in view of contrary statements recently made, again maintains (1) that the shoots found in leafy crown galls originate from groups of totipotent cells disrupted and set growing by the growth of the tumour; (2) that the crown gall organism has a stimulating effect on the formation of shoots.

Inoculation experiments on *Bryophyllum calycinum* gave the same results as those carried out on tobacco, geranium, and other plants which had given numerous crown galls containing abortive roots and shoots. It is considered inadvisable to inoculate detached leaves, as in this case the general stimulus of separation, which in *Bryophyllum* sets all the leaf buds growing, may confuse the results.

Levine's statement that the shoots in the crown gall develop from tumour cells is controverted by the author on the grounds that the tumour cell is a disoriented degenerate cell, given over to hasty vegetative growth and tending steadily toward decay; that it is not an embryo cell and there is no evidence of its subsequent development into normal tissues, organs, or the whole plant. It is also contended that, since the tissues are not killed, the appearance of numerous shoots in various parts of the tumour, resulting from inoculations in the leaf axil, can only be satisfactorily explained by ascribing their growth to dislodged fragments of the bud, containing pre-existing groups of totipotent cells. Further, the normal cortex is lifted up by a deep-seated tumour developing under it, and grows with the growth of the tumour without being actually a part of the tumour tissue, the cells having normal orientation and functioning normally. Although they are borne on the malignant tissue they do not originate from it.

The crown gall stroma (supporting tissue of vessels and mature cells) is intimately connected with the organization of the tumour, but it is not necessarily developed out of infected cells. This can only be settled when it is possible to stain the bacteria *in situ*. Meanwhile the author inclines to the view that the stroma is a growth of normal tissues (vessels and connective cells) stimulated by the presence of the abnormal cells, just as in malignant animal tumours.

When suitable inoculations are made under a dormant bud in *Bryophyllum*—that is, immediately under a petiole—not only are shoots developed from the bud under the stimulating influence of the growing tumour, but these shoots will at times develop secondary branches, as is the case in peach trees affected by peach yellows. Axillary shoots thus produced may be the only ones present on the plant.

Inoculations directly into the dormant bud and the tissues immediately surrounding it—that is, into the leaf axil—disrupt it in various directions as the resulting tumour develops, and its fragments can be seen under the microscope to be widely separated. These fragments are able to produce shoots under the tumour

stimulus, though the resulting organs may be stunted or remain mere buds owing to the restricted food and water supply.

Leaf-notch buds do not develop at all on undisturbed young shoots except when stimulated by the crown gall organism. When the inoculation is made in the vicinity of the leaf-notches most of the buds grow out into small leafy shoots, and leaves thus treated will be the only ones on the plant to bear such shoots. Single needle-thrust inoculations made directly into the dormant leaf-notch buds resulted in nearly every case in tumours and shoots, some of the smaller, slow-growing tumours bearing several shoots and roots.

Totipotent cells are rather rare in the midribs of *Bryophyllum*, hence crown galls produced in this part are usually free from leafy shoots, although it is possible to obtain them. The rarity of these cells in the midrib of *Bryophyllum calycinum* was demonstrated by sand-bed experiments which the author describes fully. If shoots are formed directly from tumour cells it is hard to understand why they should be so seldom obtained in midrib inoculations on this host.

WALKDEN (H.). **The isolation of the organism causing crown gall on Chrysanthemum frutescens in Britain.**—*Ann. of Botany*, xxxv, 137, pp. 137–138, 1921.

The author records the isolation, not previously reported in Britain, of the organism causing crown gall. It was isolated from the Paris Daisy (*Chrysanthemum frutescens*) and proved to be identical with *Bacterium tumefaciens*, the bacillus responsible for crown gall in America. Cultural studies both of the British and of an American culture received from Erwin F. Smith revealed a few minor divergences from the published accounts by Smith and his collaborators. Thus the thermal death point in the cultures examined was 44° to 46° C., while the American investigators record 51° C. The latter's classification of the organism as an acid producer seems hardly justified from the slight degree of acidity produced in dextrose and sucrose. No growth was observed to take place in Uschinsky's medium, in place of the scanty growth described in America. But these differences in no way invalidate the conclusion that the organisms causing crown gall in Britain and in the United States are identical, since they applied to both sets of cultures, and both produced typical galls when inoculated.

PAINE (S. G.) & BERRIDGE (EMILY M.). **Studies in Bacteriosis. V. Further investigations of a suggested bacteriolytic action in Protea cynaroides affected with the leaf spot disease.**—*Ann. of Appl. Biol.*, viii, 1, pp. 20–26, 1921.

The production of a bacteriolysin, which Paine and Stansfield (*Ann. of Appl. Biol.*, vi, p. 27) considered possibly to occur in *Protea cynaroides* infected with *Pseudomonas proteamaculans* P. and S., was not confirmed. The bacteria gain entrance to the leaf through the stomata. The host prevents the spread of the parasite by the development of wound cork. The explanation of the diminished number of organisms in older spots is considered to lie in the desiccation to which the tissue, cut off by the cork from

its water supply, is subjected. Tests in which the organism was inoculated into a leaf of *Protea* showed reduction in number of viable organisms from 2,808,000 on the 15th day, to 16,000 on the 32nd day. On a dry leaf surface, drops containing about 4,000,000 bacteria contained only 320 living organisms in 9 days. Tests indicated that autointoxication of the bacteria was not the cause of the reduction, but that it is rather to be attributed to the reaction of the host plant which restricts the growth of the organism in the tissues by cork formation and the production of wound gum, and the ultimate death of the organism is the result of desiccation within the area enclosed by the cork

**Byggets Stribesyge.** [Stripe-disease of Barley].—*Statens Forsøgsvirksomhed i Plantekultur, Medd.*, 80, 2 pp., 2 figs., 1921.

Both two- and six-rowed varieties of spring barley are affected by this disease in Denmark, especially the latter. The losses are very considerable, amounting in some cases to fifty per cent. of the yield. Winter barley is less liable. The symptoms are not apparent until three or four leaves are developed, and then appear as oblong pale stripes on the leaves, which gradually elongate, finally coalescing and extending the entire length of the blade. As the leaves grow older, the stripes become dry and grey, surrounded by a brown line which separates them from the green portion of the leaf. Later the leaf shreds into strips, following the direction of the stripes. The ear, when developed at all, is misshapen and brown.

The following measures of control are recommended: Disinfection of the seed with a solution of one-half per cent. of copper sulphate (500 gm. to 100 litres of water). The seed should be immersed in the solution in a basket or loosely woven sack. Severely infected seed should be immersed for four hours, half the time being sufficient in cases of mild infection. After immersion, the seed should be spread out and dried. Instead of copper sulphate, 0·5 per cent. of formalin or 0·1 per cent. of corrosive sublimate solution may be used. The latter is a strong poison and is therefore hardly to be recommended. The times of immersion are six and two hours respectively, half as long sufficing for mild infections. The hot water treatment should only be applied in cases of mild infection. This method consists in dipping the seed twenty times in five minutes in water heated to a temperature of 56–57° C. The seed should be dried preferably in the open, as artificial drying reduces the efficacy of the treatment.

JACKSON (H. S.) & MAINS (E. B.). **Aecidial stage of the orange leaf rust of Wheat, Puccinia triticina Eriks.**—*Journ. Agric. Res.*, xxii, 3, pp. 151–172, 1 pl., 1921.

The discovery of the aecidial stage of *Puccinia triticina* is announced. Teleutospores of this rust from wheat from various parts of the United States were germinated and sown on forty-eight species of plants belonging to nineteen genera. Infection occurred only upon *Thalictrum*. Tests were then made with all the species of *Thalictrum* obtainable, with the following results: *T. occidentale* was apparently immune. Pycnidia only were occasionally de-

veloped upon *T. dasycarpum* and *T. polygamum*. Pycnidia and, occasionally, a weak development of aecidia occurred upon *T. angustifolium*, *T. aquilegifolium*, *T. dioicum*, *T. minus*, *T. minus adiantifolium*, and *T. polycarpum*. Aecidia developed vigorously on two undetermined species of *Thalictrum*, and on *T. Delavayi* and *T. flavum*. Teleutospores from wheat from certain localities failed to produce infection, indicating either a different strain of the rust, or lower vitality of these spores.

Aecidiospores were sown on *Triticum aestivum*, *T. aegilops*, *Secale cereale*, and twenty-one other grass hosts. Uredo sori were obtained in all cases on *T. aestivum*, a few on *T. aegilops*, one sorus on *Secale cereale*, and negative results in all other cases (including barley). The pycnidia and aecidia obtained are described, and the relationship of this rust, which is biologically distinct from, but morphologically similar to, other grass rusts having aecidia on the Ranunculaceae, is discussed.

*Puccinia triticina* is considered to be of foreign origin, wheat being an introduced host, and the most susceptible *Thalictrums* also are exotic to North America. South-western Asia is suggested as the possible original home of the rust on native wheat and species of *Thalictrum*. While the rust seems to overwinter by uredo spores or mycelium in North America, the aecidial host may be of importance in certain parts of the world in the propagation of this rust.

STAKMAN (E. C.), KIRBY (R. S.), & THIEL (A. F.). **The regional occurrence of Puccinia graminis on Barberry.**—Abs. in *Phytopath.*, xi, 1, pp. 39-40, 1921.

Barberries growing in the southern States became heavily infected when inoculated with teleutospores produced in the northern States. When these northern-grown teleutosori were kept in the south no infection was produced on barberries. Teleutospores from the south kept in the north during the summer and fall, caused infection in the south. Evidently barberries do not become infected in the south because practically no teleutospores are viable in the spring.

JOHNSON (A. G.) & DICKSON (J. G.). **Wheat scab and its control.** —*U.S. Dept. of Agric. Farmers' Bull.*, 1224, 16 pp., 12 figs., 1921.

Scab, or *Fusarium* blight, of wheat is a disease which may be caused either by *Gibberella saubinetii* (Mont.) Sacc., or by *Fusarium culmorum* var. *leteius* Sher., or by *F. avenaceum* (Fr.) Sacc., but the first named is responsible for at least 95 per cent. of the losses, which in 1919, in spring and winter wheat alone, amounted to almost 80,000,000 bushels, while a still greater quantity suffered depreciation in value. The geographical distribution of the disease is world-wide, but it does not occur in dry regions, and in the United States the zone extends only from the Mississippi valley eastwards. The development of the fungus is dependent on weather conditions, a warm, damp atmosphere during the flowering period of the host favouring its growth and spread and leading to severe local epidemics with resultant heavy losses. Besides wheat,

the parasite also attacks rye, spelt, barley, oats, and various grasses, such as squirrel-tail grass (*Hordeum jubatum*), bluegrass (both *Poa pratensis* and *P. annua*), cheat (*Bromus secalinus*), and yellow fox-tail (*Setaria glauca*), while it is also responsible for the rot-producing disease found on Indian corn, on the dead stalks of which, as also on wheat straw, it hibernates in its perithecial stage. Hence the danger of growing wheat in rotation with maize that has been scab-infected, as the disease is carried over on the corn-stalks and breaks out in a particularly virulent form.

Wheat infected with scab is shrivelled, grey or whitish in colour, and light in weight (30 to 40 lb. to the bushel being the average for badly-scabbed grain), and the kernels thoroughly permeated by the mycelium are either graded as No. 3 and even No. 4, or else rejected altogether. An average sample of 60 lb., composed of numerous small samples taken from different elevators in Illinois in 1919, showed about 25 lb. of clean, 20 lb. of scabbed, 10 lb. of shrivelled, and 5 lb. of broken kernels. In bulk, scabbed grain occupies the same space as sound grain, but it weighs much less.

Scabby seed germinates poorly, and gives rise to blighted and weak seedlings, but these are often killed before they appear above ground. The disease spreads later to the heads, where the parasite continues to develop throughout the season. Its life during the perithecial stage is saprophytic, and although infection may take place by a direct discharge of ascospores on to the grain heads, the most common form of infection is by means of the summer-spores or conidia.

Complete suppression of the disease is difficult to attain, but the losses due to it can be greatly minimized by (*a*) not sowing wheat after corn, unless the cornstalks are removed and the stubble completely ploughed under; (*b*) ploughing under all crop refuse and collecting and burning all old straw and grasses in the immediate neighbourhood; (*c*) using clean, graded, and treated seed of adapted varieties; (*d*) sowing wheat when the ground is cool, winter wheat on the latest safe date of the season, and spring wheat on the earliest safe date in the spring.

DICKSON (J. G.). **The influence of soil temperature on the development of the seedling blight of Cereals caused by Gibberella saubinetii.**—Abs. in *Phytopath.*, xi, 1, p. 35, 1921.

Uninfected wheat seedlings developed best in soil temperatures below 16° C.; maize seedlings at temperatures above 20° C. Blight of wheat seedlings did not occur at soil temperatures below 12°, but was severe at temperatures from 16° to 28° C. Maize seedlings blighted at 20° C. or below, and did not blight above 24° C. Comparable results were obtained in the field.

STEVENS (F. L.). **Helminthosporium and Wheat foot-rot.**—Abs. in *Phytopath.*, xi, 1, p. 37, 1921.

An adaptation of the rag-doll seed tester, in which seedlings were grown under aseptic conditions, and moisture and temperature varied as desired, was used to study seedling infection of wheat by the *Helminthosporium* of foot-rot. Inoculation on the uninjured sheath was followed by penetration within twenty-four hours and

the development of a visible brown spot within forty-eight hours. In favourable conditions the mycelium subsequently invaded the innermost leaves and caused general rotting and death. When inoculated on roots there was a general invasion of the cortex with very slight discoloration. A number of cultures of closely related *Helminthosporiums* from different sources, some sent under the names *H. teres*, *H. avenae*, *H. gramineum*, and even *H. interseminatum*, showed the same infecting ability. Infection is through the middle lamella. The mycelium forms appresoria, the middle and inner lamellae swell, and they and the adjacent cellulose walls change in staining reaction. On the inside of the host-cell callus-like bodies develop. A geniculate-spored *Helminthosporium* caused abundant mycelial invasion, but extended to only a few cells. Infection by the foot-rot *Helminthosporium* was secured on maize, barley, rye, corn-fodder, Sudan grass, and millet.

WESTON (W. H.) Jr. **Significant points in the life-history of the Philippine Maize mildew.**—Abs. in *Phytopath.*, xi, 1, p. 32, 1921.

A warning is given of the menace to the American corn crop caused by the presence of several destructive species of *Sclerospora* on *Zea mays* in the Orient. The Philippine species produces its conidia only at night, but may continue to do so for over two months. Conidia may be produced on corn, teosinte, sorghum, sugar-cane, *Saccharum spontaneum*, and *Miscanthus japonicus*. Oogonia are found only on the last three hosts. The conidia do not survive drying, so that spread to other countries is only likely through the transportation of oogonia in soil or on plant parts, or of infected living plants such as sugar-cane cuttings.

HEALD (F. D.). **The relation of spore load to the per cent. of stinking smut appearing in the crop.**—*Phytopath.*, xi, 7, pp. 269–278, 1921.

Single smut balls of *Tilletia tritici* were found to contain from six to nine million spores. During threshing, from 0 to 45,416 spores were found to become deposited on single grains of wheat in Washington. Tests were made by adding 0·005 to 3·0 gm. of bunt spores to 100 gm. of wheat (giving spore loads per grain respectively of about 400 to 183,000) and planting the seeds in clean soil. At least 0·5 gm. of powdered smut per 100 gm. of seed (about 35,000 spores per grain) was found necessary to produce the maximum amount of smut on the crop. In the case of naturally smutted seeds, a lesser per cent. of smut occurs in the crop than when the same number of spores per grain are added from freshly broken bunt balls, indicating that the spores retain their vitality better in unbroken balls. A spore load of 533 spores per grain was found to produce 9·52 per cent. smutted plants in the variety Jenkin's Club, whereas the same spore load resulted in no smut being produced with the Marquis variety. Marquis was seldom found bearing sufficient smut spores after threshing to necessitate seed treatment. The author considers that the necessity of having considerable numbers of smut spores in order to secure infection indicates either a multiple infection or a chemical mass effect due to numbers of spores.

It was found possible to predict the amount of smut that may appear, from a count of the spore load of seed examined.

KOCH (ELIZABETH) & RUMBOLD (CAROLINE). **Phoma on sweet Sorghum.**—*Phytopath.*, xi, 7, pp. 253–268, 3 pl., 3 figs., 1921.

A *Phoma* was found on seedling leaves, and the leaves, seed heads, and seed of mature sweet sorghum plants from Arkansas, Kansas, Mississippi, Texas, and Virginia. The fungus caused infection in cross-inoculations upon eleven varieties of grain sorghum and sweet sorghum, and upon the forage sorghum Brown Durra. Seeds bearing pycnidia were found when planted to produce in some cases infected seedlings and to show poorer germination than healthy seeds. Slight infection was produced on sugar-cane and *Zea mays*. The cultural characters of the fungus from various varieties of sorghum are described, and while variation occurred in the morphological and physiological characters of the fungi from different sources, these variations were not considered of sufficient constancy nor degree to warrant special naming of the strains. The fungus is tentatively assigned to *Phoma insidiosa* Tassi.

The fungus was found to retain its vitality on seed for one year, but the vitality was poor at the end of two years.

RUMBOLD (CAROLINE) & TISDALE (ELIZABETH K.). **Notes on Phoma insidiosa Tass. found on Sudan grass.**—*Phytopath.*, xi, 8, p. 345, 1921.

Brownish-drab spots with indefinite outlines, bearing pycnidia of *P. insidiosa*, were found on Sudan grass. Cultures were obtained, and infection produced on Early Amber sweet sorghum.

The original culture from Sudan grass did not produce a pink stain in the medium, but the re-isolation from the sorghum produced this stain, just as the fungus found naturally on sorghum did. A number of measurements of pycnidia and conidia from leaves and cultures is given, there being considerable differences according to the source of the fungus between the limits of 45 and 198 $\mu$ for the pycnidia and 4·4 to 7·9 × 2·6 to 4·4 $\mu$ for the conidia.

ROSEN (H. R.). **Further observations on a bacterial root and stalk rot of field Corn.**—*Phytopath.*, xi, 2, pp. 74–79, 4 figs., 1921.

From rotted roots, stalks, leaves, and husks of maize in Arkansas, accompanied by brown discoloration of the nodes, the writer has isolated a rapidly growing, white bacterium, capable of reproducing the disease. Under favourable conditions, such as high humidity and temperature, the rot rapidly spreads through the thickness of the stem, the tissues collapse and disintegrate, and the stalk falls over. At times 10 to 30 per cent. of the plants may be attacked.

SEYMOUR (EDITH K.) & MCFARLAND (F. S.). **Losses from rye ergot.**—*Phytopath.*, xi, 7, pp. 285–289, 1921.

Spikes of rye (*Secale cereale*) affected with *Claviceps purpurea* contain a larger number of blasted kernels or empty florets than do normal spikes. The majority of these blasted kernels or empty florets have been penetrated by the fungus. Thus in one count

made, 70 per cent. of the florets were infected by the fungus, though only 21 per cent. bore sclerotia. On an average of a number of counts it was found that ergotized spikes contained only 43 per cent. of normal kernels while unergotized spikes had 69, the larger part of the difference being made up of parasitized florets without sclerotia. Hence the losses caused by the disease are decidedly greater than those merely due to the replacement of normal grain by sclerotia.

A(SHBY) (S. F.). **Relation between Cacao pod rot and Coco-nut bud rot.**—*Agric. News (West Indies)*, xx, 507, p. 318, 1921.

In view of the apprehension caused by Reinking's work in the Philippines as to the ability of the cacao pod rot fungus (*Phytophthora faberi* Maubl.) to cause bud-rot of the coco-nut, the writer carried out some experiments to determine whether the species of *Phytophthora* from cacao (*P. faberi*) and from coco-nut (*P. palmivora* Butl.) in the West Indies would cross-inoculate and whether they appeared to be identical when grown in pure culture on the same media.

Inoculations from pure cultures of the two fungi were carried out on two coco-nut seedlings, each about three feet high, by pushing a stout needle into the heart at a point about six inches above the attachment to the nut. Round the hole thus made a cup of plasticine was moulded and filled with sterilized water containing active zoospores and undischarged sporangia. The stem was surrounded by a glass lamp-chimney closed below with a perforated cork and plasticine, and above with a plug of cotton wool. Examination after four weeks showed that the young tree inoculated with the coco-nut *Phytophthora* had rotted spots on the pinnae of the heart leaf, three-quarters of an inch in diameter, both on the leaflets pierced by the needle and on those not wounded; a rot had also run down the stalk and expanded in the tender tissues below the growing point of the stem, and mycelium characteristic of the fungus was found in all the affected parts. The second tree, which had been treated with *Phytophthora* obtained from rotted cacao pods, exhibited no signs of infection, except spots under one-third of an inch in diameter on the leaflets in the heart pierced by the needle.

The experiment was repeated, in co-operation with Mr. R. O. Williams, the Agricultural Superintendent in Grenada, but this time the attempt was made on four coco-nut seedlings, of the same size as those in the preceding test, with a zoospore suspension from a pure culture of the cacao *Phytophthora* only, poured into the hearts. The trees were wrapped in damp cotton cloths which were kept wet for several days during a period of showery weather. A month later two of the trees proved quite free from spots on the young leaves or rot in the hearts, while the lapse of another month found the other pair equally free from infection.

Similar experiments were conducted with cacao pods, of which twelve large but immature specimens were inoculated with each of the two fungi from pure cultures, by placing drops of a zoospore suspension containing also undischarged sporangia at two points in each pod, after the surface had been sterilized in corrosive sublimate

and well washed with boiled water. The surface of the pod covered by the drop was wounded with the point of a scalpel, the inoculated places enclosed in plasticine cells, and the pods kept in a damp chamber. Of the twelve pods inoculated with the cacao fungus, nine showed a brown rot expanding from the drops after two days, becoming wholly rotted after seven to ten days, and with abundant sporulation. The remaining pods rotted after a second inoculation. In the twelve pods inoculated with the coco-nut fungus no sign of infection could be detected after a week, and repeated inoculations produced negative results. A second series of experiments in co-operation with the Agricultural Superintendent in Grenada confirmed the above findings in every way. The pods used were mostly red and yellow Amelonado forms of Forastero, a few being Angolota, and none Criollo.

A comparison of the two fungi in pure cultures isolated from various localities in Jamaica showed only minor differences, but in none of them were oospores (the only sound basis for the natural separation of species in the genus) found. Until such spores are met with, either in cultures or under convincing conditions in nature, a decision as to whether the two West Indian forms belong to different species or are different biological varieties of one species cannot be made. The experiments recorded, although not comprehensive, indicate that the cacao *Phytophthora* does not appear to attack the coco-nut, and that cacao pods cannot be rotted by the form which causes bud-rot of the coco-nut.

SHARPLES (A.) & LAMBOURNE (J.). **Observations in Malaya on bud-rot of Coco-nuts.**—*Ann. of Botany*, xxxvi, 141, pp. 50-70, 7 pl., 1922.

After a brief discussion of previous work done on the bud-rot of palms in the West Indies, India, and the Philippines, the authors describe a small outbreak of bud-rot in Malaya, in a three-acre field, in which practically every tree showed signs of the disease, while some were in a very advanced state of decay; the field was subjected daily to tidal inundation, to which, as a primary cause, the disease was attributed. A large number of specimens in all stages of decay were examined and found to contain no apparent fungal hyphae; isolations made from the advancing margin of the diseased tissue showed, however, the presence of three organisms, a red pigment producing bacillus, a bacillus resembling *B. flavo-coriaceus* Eisenberg, and a *Sarcinomyces*. These organisms were used by the authors both singly and also the first and last in combination, for a series of inoculations on mature palms. A small sterile gouge was inserted in the clean heart tissues of the bud; the tissue extracted by it was inoculated with the organisms under trial and then replaced in the bud. Most of the inoculated trees developed the early symptoms of bud-rot, characterized by the rotting and falling over of the central leaves, but subsequently recovered and put out new leaves from the side of the bud below the remains of the central shoot. Further inoculations were made with the *Phytophthora* causing black stripe of *Hevea brasiliensis* in Malaya [which the authors identify with *P. faberi* Maubl.] and

with a species of *Thielavia* and a *Mucor*, all of which gave results similar to those of the first set of experiments.

The authors conclude that wound inoculations penetrating the central tissues of the bud will produce the symptoms of bud-rot, as judged by the rotting of the central leaves, with a variety of organisms, none of which can be regarded as specific to the disease. The only case in which the bud itself (the growing point) was definitely rotted was in one of the inoculations with *Phytophthora*. They consider that in most of the other work done on this disease, sufficient time was not allowed to elapse before completing the observations to judge whether the parasite was capable of killing mature trees. Inoculations on seedlings are open to the objection that the seedling has not the same defensive powers as the mature plant. Hence the authors are not prepared to admit that the cause of bud-rot has been established, and while they state that *Phytophthora palmivora* Butl. has been proved in India and the West Indies to function as an obligate parasite on the tender central leaves of the palms, they do not think that it necessarily causes rotting of the heart tissues and death of the tree.

PETHYBRIDGE (G. H.), LAFFERTY (H. A.), & RHYNEHART (J. G.). **Investigations on Flax diseases (Second Report).**—*Journ. Dept. of Agric. & Techn. Instr. for Ireland*, xxi, 2, pp. 167–187, 6 pl., 1921.

This is a continuation of the investigations reported in the same journal, xx, p. 325, 1920. The warm damp weather experienced in 1920, though eminently suitable for flax growing, favoured equally the development and spread of parasitic fungi. Special attention was directed to the following diseases:

SEEDLING BLIGHT. The method of seed infection was traced. Infected fruits are marked with reddish-brown areas, and when placed in a moist, warm atmosphere for forty-eight hours develop the fructifications of *Colletotrichum linicolum* P. & L., the cause of the blight. The mycelium penetrates within the tissues of the fruit wall to the central axis and along the extremely short funicle into the outer layers of cells of the seed-coat, where it is localized. As to the infection of the fruits themselves, the writers have practically no doubt that this occurs from already infected leaves, the fungus progressing in stages from the seed to the young seedlings, some of which do not succumb to the attack, and thence to the leaves as these are developed, until it finally reaches the fruit. It has hitherto not been possible to undertake seed disinfection trials. It is thought that the parasite may be identical with *Gloeosporium lini* mentioned by Westerdijk in *Jahrb. Ver. Angew. Bot.*, xvi, p. 4, 1918.

'BROWNING or STEM-BREAK' (*Polyspora lini* Laff., n. gen. et. sp.). These are only two phases of a disease caused by one and the same parasite with apparently a world-wide distribution. The chemical changes brought about by this fungus cause a lignification of the wall of the fibres with the result that the stem becomes brittle in the diseased region.

As in the case of 'Seedling Blight', the transmission of the disease occurs through the seed, but attempts to check this have so far met

with failure. Steeping infected seed is inadvisable, as it becomes mucilaginous when wetted, with the result that in the drying process the seeds adhere together, whilst their vitality is greatly reduced. This difficulty has been overcome by using a very fine misty spray and by employing comparatively small quantities of the following solutions: 5 and 10 per cent. aqueous solutions of copper sulphate; 2, 10, and 15 per cent. Burgundy mixture; 0·1, 0·5, and 1 per cent. aqueous solutions of mercuric chloride; and 0·37, 0·48, and 0·59 per cent. aqueous solutions of formaldehyde. The 0·59 per cent. formaldehyde solution was the only one that effectively checked the disease, but in practice it can hardly be regarded as a useful method of control, as the percentage of germination is seriously reduced, and to counteract this much greater quantities of seed than usual would have to be sown. In attempts to disinfect the seed by heating, it was found that the vitality of the fungus was not impaired when the seeds were exposed to a temperature of 50° C. for periods of from 6 to 192 hours, the longer exposures also slightly improving germination. Nor were the conidia killed at temperatures up to 80° C., prolonged up to 168 hours, but death occurred after a 30-hour exposure to a temperature of 96·5° C. A period of rest after this treatment improved the germination of the seeds considerably, but it never rose above 54 per cent., as compared with 94 per cent. in the control seeds. It follows from these trials that, for the present at least, preventive measures will have to be employed to minimize the very serious losses resulting from this disease. Care in the choice of the seed for sowing, which should never be taken from a 'browned' crop, is essential, and much valuable fibre can be saved and further spread avoided by 'pulling' a crop that shows signs of the disease.

There is an erroneous idea that white flowering flax is resistant, but this is simply due to the fact that it is generally pulled before 'browning' has become epidemic in it. A full description of the fungus is being published in a separate paper. [See next abstract.]

'Rust' and 'Firing'. The full life-history of the flax rust, *Melampsora lini*, had not been previously followed in Europe, though known in America. The authors have found all four stages on flax in Ireland. The spermagonia appear about fifteen days after the infection of young plants with germinating teleutospores, and are followed a few days later by aecidia. The flask-shaped or spherical, immersed spermagonium has a minute beak with an ostiole opening directly underneath a stoma, or occasionally two, each beneath a separate stoma. The spermatia borne on branched stalks within the spermagonium are extruded to the exterior through the ostiole and the stoma in the form of a tendril. The walls of the spermagonium are formed of compacted hyaline hyphae with yellowish contents. All attempts to germinate the spermatia failed. The raised aecidial pustules are generally crescentic or annular in shape. In the latter case the leaf tissue within the ring is not raised and contains spermagonia. The aecidia themselves, arising beneath the epidermis of the leaf, rupture it, and thus the chains of aecidiospores lie freely exposed. Inoculations with the aecidiospores gave uredo pustules in nine days, followed by the teleutospore stage twenty-two days later. Spread takes place

chiefly in the uredo-stage. Experiments have shown that the disease is not transmitted by seed that has been thoroughly cleaned, even if derived from a rusty crop. It is therefore important to remove as thoroughly as possible all fragments of the previous crop on which the teleuto-stage may occur, when preparing the seed.

'FOOT-ROT' is the name suggested by the authors for a disease which was included in their earlier report under the general designation of 'dead stalks', but is now found to be due to a definite parasitic fungus belonging to the genus *Phoma*. Its species has not been determined as yet, but it is of interest to note that on the Continent two species, *P. herbarum* and *P. exigua*, are considered harmful to flax; it does not, however, appear that exhaustive investigations into their influence on the crop have been carried out. In the disease here described the flax plants die prematurely, while the lower parts of the stem are covered with numerous dark brown or black pycnidia. Spores are produced in vast quantities in these and emerge through a minute pore to the exterior. The mycelium, ramifying in the cortical cells of the stem, destroys the fibres and chokes up the cavities of the vessels of the wood. The parasitism of the *Phoma* in question was established by inoculations with pure cultures, and it was proved that the disease can be transmitted through the soil, though it is still an open question whether this occurs under field conditions, and also whether the seed carries the disease.

FLAX WILT (*Fusarium lini*). Wilting on a large scale appears to be rare in Ireland, and in contrast with the western parts of the United States the occurrence of flax 'sick' soil as a result of the presence of this fungus is almost unknown there. The wilting of individual plants, however, is not uncommon, and in some cases may be fairly extensive. It affects both seedlings and more mature plants, but there are no external symptoms beyond wilting, and the presence of the fungus is only discovered by examining the internal tissues when it is found that the wood vessels are choked with mycelium. Laboratory experiments prove that infection may occur through the soil, and that the fungus retains its vitality unimpaired after eight months in potted soil. Whilst the results have as yet not been checked by trials in the field, they nevertheless make it appear probable that the fungus hibernates in the soil and renews its attack on the host the following season. In America, where the disease is very prevalent, the opinion prevails that it is transmitted through the seed, by means of spores mechanically adhering to the seed-coat, and disinfection of the seed is strongly advocated. It has not been possible to test this statement fully, but the interesting fact has been noted that the fungus survives the retting process, and affected plants accidentally left behind in the drying-field may conceivably carry infection to a succeeding crop. Resistant varieties have been raised in America, mainly of the oil-producing kind, but the lesser severity of the disease has made this unnecessary in Ireland. The fungus has been compared in culture with that isolated from wilted flax in America and British East Africa, and the same species, *Fusarium lini*, appears to be common to the three countries.

BOTRYTIS DISEASE. The species has not been determined, nor whether it is one which is common to a number of plants. On flax, infection usually occurs on the stem, at any point, and the tissues are here quickly destroyed, while the upper portion of the plant dies. In one case, however, progression of the infection from above downwards was noted in plants infested by Capsid bugs. The upper portions of these plants ceased to elongate and branched abnormally, and the *Botrytis* attack took place in these upper portions, infection being possibly favoured either by the wounds made by the insects or by the lowered vitality of the plants. The latter were killed outright before any fruits or seeds had developed. The authors consider it practically certain that the sclerotia produced by the fungus on the dead tissues survive the winter, and the disease may arise through their agency in the following year.

SCLEROTIUM DISEASE (*Sclerotinia sclerotiorum*). This parasite attacks a large number of different plants, but it was only once met with causing a rot of lodged flax. Inoculations with pure cultures of the fungus showed it to be a virulent parasite.

YELLOWING. The most careful examination failed to reveal the presence of a parasitic organism, and the cause of the disorder, which is characterized by a chlorotic and stunted appearance of the young seedlings, appears to be, in some cases at least, a result of unsuitable soil conditions.

LAFFERTY (H. A.). **The 'browning' and 'stem-break' disease of cultivated Flax (Linum usitatissimum) caused by Polyspora lini n. gen. et sp.**—*Scient. Proc. Royal Dublin Soc.*, xvi, N. S., 22, pp. 248–274, 3 pl., 1921.

This is a fuller description of the organism and its effects already referred to in a paper by Pethybridge and the present author [see last abstract]. There is a Latin diagnosis of the fungus and an account of its behaviour under cultural conditions. The symptoms of both forms of the disease are dealt with in detail. 'Browning' in the crop first becomes evident about pulling time, either in isolated areas which gradually increase in extent until they coalesce, or more or less uniformly over the whole field if the primary infection is general from the start. Weather conditions influence its rate of development, spread being most rapid in warm damp weather. One diseased centre, about one foot square in area, was found to have increased in three days to an irregular area of seventy-two square feet. On the leaves the characteristic dark brown, rounded, usually sharply defined and slightly depressed spots appear either singly or in considerable numbers, as many as eight having been found on a single leaf. They do not increase in size very rapidly, and except when the attack takes place in the region of the petiole, the leaves are able to continue their functions for a long time after infection; in every case, however, the ultimate result is premature death, the leaf turning brown and either falling or remaining with its surface adhering to the stem. The diseased areas in the main stem, which are often closely associated with the presence of an affected leaf situated at a slightly higher level, appear at first as minute, elongated, light fawn to brown spots, which gradually spread, especially in a longitudinal direction,

and may coalesce until practically the entire surface of the stem is covered. In dry weather the cortex frequently splits longitudinally along a diseased area, and the stem at this point becomes extremely brittle. Branches are similarly attacked and frequently girdled. Diseased petals turn brown and commonly adhere firmly to the wall of the fruit. The latter, when infected in the early stages of the growth, can easily be picked out, but detection is extremely difficult when the fruits mature, as they then lose their green colour naturally and become golden or light brown in colour. Diseased tissues contract owing to loss of moisture, and affected fruits tend to gape open, particularly in dry weather. In cases of light infection the seeds may appear normal to the naked eye, but the majority are found on closer examination to be heavily infested with the parasite.

Stem-break is produced by the occurrence of an infected area in the neighbourhood of the first node, the stem breaking across more or less completely at this point. When the fracture is complete the plant turns brown and dies, but if the woody tissue of the stem is well developed the fracture may be only partial and the parts above continue to live and grow for a time.

The hyaline, septate, and branched hyphae, which in the early stages of the disease permeate the parenchymatous tissues of the cortex and destroy the cells between the fibre bundles, discolouring and disorganizing their contents and consuming the chlorophyll granules, have never been seen to penetrate the bundles themselves, though an alteration in the chemical composition of the latter undoubtedly takes place. This alteration affects both the fibre walls and the middle lamellae, which become lignified. Young seeds attacked before the seed-coats are fully developed are totally destroyed as the embryo becomes infected, but in the more fully developed seeds the fungus is stopped by the third or fibrous layer of the seed-coat and the embryo escapes.

On and around the margins of the discoloured diseased areas, kept in a moist atmosphere, beehive-shaped, hyaline to milky, gelatinous acervuli are produced (as a rule directly over the stomata) by considerable masses of hyaline, single-celled conidia of varying shape, oval, cylindrical or curved, borne on the swollen tips of usually unbranched conidiophores emerging slightly through the stomata. Occasionally on affected stems and branches but not on leaves, submerged conidia are formed which accumulate in minute pockets beneath the epidermis until pressure from below causes them to burst to the outside. No true stromata are formed and setae have never been found. The conidia are produced in clusters at the ends of the conidiophores and occasionally for a short distance along their sides, from one to seven being formed at a time, and new ones developing after the first have fallen off. They are 9 to 20 by 4 to 5 $\mu$ in diameter. On germination in culture the amount of mycelium produced is small, but new conidia are formed in great abundance, often directly from the conidia by budding. In culture a dark-coloured mycelium of rounded cells may be formed and the conidia may occasionally take up this colour. On cooked flax stems the tips of the conidiophores may be olive-green. On all the media conidia are budded off from the sides of the hyphae

on short blunt pegs, which may bear two or more spores. The conidia frequently become septate before germination. The fungus is regarded as belonging to the Melanconiales, and attention is called to certain similarities with *Microstroma*, though the latter is usually regarded (except by Maire) as belonging to the Exobasidiaceae.

Inoculations with pure cultures were successful and no evidence was obtained of varietal resistance or of separate strains of the fungus.

SANDERS (G. E.) & KELSALL (A.). **Dusts and dusting for insect and fungus control.**—*Scient. Agric.* [Canada], ii, 8 pp., Sept., 1921.

This article deals with dusts containing copper and arsenic, and is continued from a preceding article entitled 'The present status of dusting'.

Paris green is a well-known copper-arsenic dust, but is a poor fungicide and is expensive. Commercial Bordeaux powders, made usually by mixing copper sulphate solution and milk of lime and drying the precipitate, are good fungicides. A new copper-arsenic dust was devised by the authors in 1917. In 1921 about 700 tons of this dust were used in Nova Scotia. In the Annapolis Valley of Nova Scotia about 10,000 acres of apples were thus dusted in 1921, 8,500 acres were sprayed (principally with Bordeaux), and about 1,500 acres were dusted with sulphur-lead arsenate dust.

In making their dust the authors first used anhydrous $CuSO_4$, but later the mono-hydrate, $CuSO_4H_2O$, was generally used. This salt is ground fine enough to pass a screen of 200 meshes per inch. Calcium arsenate is at present considered the most satisfactory arsenical salt to add to the dust. Powdered hydrated lime is added to give the necessary bulk. The strength of these dusts has been expressed in the percentage of metallic copper and metallic arsenic respectively. Thus a $3\frac{1}{2}$–$1\frac{1}{4}$ dust has been recommended since 1919 for apples, and is made up with 10 lb. of dehydrated $CuSO_4$ (containing 35 per cent. of metallic copper) and 5 lb. of calcium arsenate (containing 26 per cent. of metallic arsenic). The remaining 85 lb. are hydrated lime. For potatoes a $5\frac{1}{2}$–$2\frac{1}{2}$ formula is recommended at present. These dusts may be stored in any dry place, but should be used the same season in which they are mixed. When the dust is applied to a leaf, the first contact with water (rain or dew) changes the white powder to a blue film of Bordeaux mixture. The dust has better spreading power than sulphur dust. For an acre, 55 lb. of copper-lime dust, 73 lb. of 90–10 sulphur-lead arsenate dust, or 100 gallons of Bordeaux mixture were required.

In order to determine the relative adhesiveness of the copper-arsenic dust and of Bordeaux mixture, leaves were picked from dusted and sprayed apple-trees, and the amounts of copper and arsenic remaining after various lengths of time had elapsed, were determined. These tests indicated that as much copper and arsenic are found on the leaves immediately after dusting as after spraying, indicating that there is no greater wastage of material in dusting than in spraying. The spray was found to adhere to the leaves

longer than did the dust. Tests of dusts of different strengths indicated that apple leaves will stand up to six per cent. of metallic copper and four per cent. of metallic arsenic in dusts without suffering injury. Some russeting of the fruit is produced, but less than that caused by Bordeaux spray, and this russeting can be much reduced by using sulphur for the application immediately after the blossoms fall.

The scarcity of codling moth and certain other insects renders the value of the copper-arsenic dust for insect control of some uncertainty, but the dust may be slightly inferior to the spray in this respect. Dusting is equal to spraying in the control of apple scab.

SANDERS (G. E.). **Spraying and dusting.**—*Fruit Growers' Assoc. Nova Scotia, 57th Ann. Rep.*, pp. 66–92, 1921.

A brief history of the use of several preparations for the control of plant pests is given. The author reports that field tests of dusts and sprays allow the following conclusions to be drawn, with special reference to applications to apple-trees in Nova Scotia:

When less than 10 per cent. of lime is added to lead arsenate, the amount of burning is increased, but when the amount of lime is equal to the lead or more, the burning is decreased. Thus the lime usually left in a spray tank is likely to increase the burning from what is intended to be straight lead arsenate, but the addition of more lime will decrease the burning. When alkaline diluents, such as hydrated lime, talc, &c., are added to sulphur dust, the fungicidal value is reduced. Where lead arsenate is added to sulphur dust, the fungicidal value is increased. This last he thinks is mostly due to physical improvement.

Dolomite lime renders the copper in Bordeaux and copper-arsenic dust safer on foliage and fruit than high calcium lime. The copper in Bordeaux and in copper-arsenate dust has a much greater effect in rendering the arsenicals safe than the lime. The refusal of white arsenic to wet readily when placed in water and its refusal when alone to react on copper sulphate, are both overcome by the addition of a small quantity of hydrated lime.

Spray calendars and dust calendars for apples in Nova Scotia are given. The dust calendar recommended is as follows: Before the blossoms, apply copper-arsenic dust two or three times. Immediately after the blossoms, on varieties liable to russeting use sulphur-lead arsenate dust; on other varieties use copper-arsenic dust as before. A week or ten days after the last application and at equal intervals thereafter give two or three applications of copper-arsenic dust.

Practical details as to the best time of day and best method of applying the dusts are given. It would appear that many of the growers are abandoning spraying in favour of dusting. The latter is preferred because it is quicker and allows a greater acreage of trees to be protected with one outfit. Summaries of tests in Nova Scotia and elsewhere for four years indicate that dusting is equal to spraying in controlling scab and insects on apples. Dusting with copper-arsenic dust is cheaper than liquid spraying. The copper and arsenic dust is made of 10 lb. of dehydrated copper

sulphate, 5 lb. of arsenate of lime, and 85 lb. of hydrated lime. 50 lb. are recommended per acre of twenty-year-old trees. The sulphur-lead arsenate dust is composed of 90 lb. superfine dusting sulphur and 10 lb. dry lead arsenate. It is used at the rate of 75 lb. per acre of twenty-year-old trees.

CHIFFLOT (J.). **Les maladies cryptogamiques des Abricotiers dans la vallée du Rhône.** [Cryptogamic diseases of Apricot trees in the Rhone valley].—*Ann. des Épiphyties*, vii, pp. 315-322, 1921.

The importance of the fruit production of the Rhone valley is shown by the fact that in 1920 over 10,000 tons of apricots and peaches were dispatched to the various markets and sold at an average price of fr. 120 per 100 kg. The apricot orchards, interspersed with market gardens, are situated on the low-lying parts bordering the river and on the slopes of the valley. Cultivation is neglected and little is done to check diseases, with the result that returns are much below what they should be.

The two principal diseases found on the apricots are brown rot due to *Stromatinia* [*Sclerotinia*] *laxa* Ehrenb. (*Monilia laxa* (Ehrenb.) Sacc. and Vogl.), which some phytopathologists look upon as a form of *Stromatinia* (*Monilia*) *cinerea* Bon., and *Clasterosporium carpophilum* (Lév.) Aderh. (*Coryneum Beyerinckii* Oud.). The former attacks flowers, buds, fruits, and twigs, which mummify and become covered with the grey efflorescence of the *Monilia* stage. This mould is also found on the base of the petioles and on the cicatrices left by the fallen buds and flowers, while affected twigs exude through the ruptured cuticle a gummy secretion, at times abundant. Damp weather favours the development and the spread of the parasite, which is essentially a low temperature organism. The years 1913, 1915, and 1916 were particularly favourable to it, the fruit yield in France being reduced by 80 to 90 per cent. Infection probably takes place through the stigmas when the flowers first open, and spreads rapidly through flowers and buds to neighbouring twigs and from these in due course to the fruits.

The second disease also attacks the flowers, twigs, and fruit but does less damage than the first. On the twigs pink spots are formed which later turn brown and may give out a gummy secretion, this being the only point of resemblance to the *Monilia*. The leaves are also covered with pink spots which become brown and fall out. The fruit is sometimes severely affected, the pulp drying up between the brownish spot and the centre of the fruit.

Treatment is the same for both diseases. Rotted fruits and dead wood should be burned, not buried, and the trees sprayed during the winter with Bordeaux or Burgundy mixture or neutral verdet. Several applications during January, February, and just before and after flowering are recommended. Scott's self-boiled lime sulphur is also stated to be efficient and easy to prepare. Of the varieties of apricots grown in the Rhone valley, Luizet is the most resistant and is followed by Abricot d'Ampuis, Blanc rosé, Paviot, and Poizat, in order of resistance.

LEONIAN (L. H.). **Studies of the Valsa Apple canker in New Mexico**—*Phytopath.*, xi, 6, pp. 236–243, 1921.

Twigs, branches, or the main trunk of apple-trees in New Mexico were found to bear cankers covered with the fruiting bodies of a fungus, mostly pycnidia apparently identical with the *Cytospora* described by Stevens (*Ill. Agric. Expt. Stat. Bull.*, 217, 1919). A few perithecia were, however, found, which resembled *Valsa leucostoma* (Pers.) Fr. Both pycnidia and perithecia were developed in culture and their relationship demonstrated. Inoculations with conidia on steamed apple twigs were found to yield only pycnidial stromata, but similar cultures from ascospores gave both forms of fructification. Inoculations in the field with conidia and ascospores of the fungus, and also with conidia from cultures of a plum strain of *Cytospora leucostoma*, gave rise to typical lesions and fruiting bodies. *Cytospora chrysosperma* was found to be unable to attack apple-trees.

A cultural study of the fungus indicated that cane-sugar and sodium chloride, under proper conditions, acted as stimuli to the formation of perithecia on oatmeal agar. Inoculation experiments on apple-trees in the field showed that the fungus is a weak wound parasite, and will not attack vigorous trees. In natural attacks discoloured sunken lesions are formed which may extend along the entire length of the branches. The margin of the lesion is wrinkled, peeling, and split, with often also a purplish zone which marks the advance of the fungus. On the trunk the bark becomes swollen and soft at first, then dries and shrinks. The effect of a trunk canker is to give the tree a sickly appearance, the leaves remaining small, fading, and dropping off. In branch attacks the parts dry up and defoliate more rapidly.

RAVAZ (L.) & VERGÉ (G.). **Sur la germination des spores du mildiou de la Vigne.** [On the germination of the spores of the Vine mildew.]—*Comptes Rendus Acad. des Sciences*, clxxiii, 25, pp. 1421–1423, 1921.

Certain of the natural water supplies in the neighbourhood of Montpellier have been found to inhibit the emission and germination of the summer zoospores of *Plasmopara viticola*, while the town water supply and water distilled in glass give irregular results. This unfavourable action, which cannot be explained by differences in electrical conductivity, can be neutralized by the addition of minute quantities of sulphuric or carbonic acid or even of copper sulphate.

In rain water, dew, and twice distilled water germination is regular.

Attempts were made to study the toxic effects of various substances added to rain water. It was found that besides the toxic effect other factors were important, especially the volume of solution, its surface tension (which affects the degree of immersion and wetting of the spores), and the concentration of the spores in the liquid. It was found that the spores do not germinate in rain water containing 1 : 50,000 of sulphuric acid or between 1 : 300,000 and 1 : 400,000 of copper sulphate (corresponding to an average of 1 : 1,000,000 of metallic copper); sodium carbonate is active only in

the proportion of 1:7,000 to 1:8,000; while saturated solutions of sulphate of lime do not prevent germination. Spores sown in solutions of lime and of soda, kept under glass jars from which all the carbonic acid has been eliminated, failed to germinate up to dilutions of 1:70,000 to 1:80,000 for lime and 1:20,000 for soda, but in ordinary air these solutions very rapidly lose their toxicity owing to carbonization which, in the case of the lime solutions, becomes apparent in less than twenty-four hours by the formation of a surface film of calcium carbonate crystals. A six per cent. milk of lime sprayed on leaves kept over night in damp air under a glass jar will not react to phthalein the next morning. It takes, therefore, a very short time, in some cases less than a night, for the lime contained in copper mixtures to be more or less completely neutralized, and this fact explains the lack of success obtained with fungicides in which lime is the only active substance.

It has been stated that atmospheric water can dissolve only extremely small quantities of copper, too small to inhibit germination of the spores of *Plasmopara viticola*. The authors, however, found on examining dew from leaves sprayed with a weakly alkaline copper mixture, that it contained a high proportion of copper, corresponding to from 1:7,000 to 1:10,000 of copper sulphate. Rain water collected after passing over sprayed leaves showed proportions of from 1:50,000 to 1:10,000 of copper sulphate according to the heaviness of the rainfall, and in such water germination did not take place. The water remained toxic even when collected up to twenty days from spraying, though there had been several heavy falls of rain in the intervening period.

The authors conclude that lime loses its fungicidal properties too rapidly to be of practical value, while lime and copper mixtures resist the action of rain and dew and yield sufficient quantities of copper to inhibit germination of vine mildew spores for a long time after application.

HAUMAN (L.) & PARODI (L. R.). **Los parásitos vegetales de las plantas cultivadas en la República Argentina.** [Vegetable parasites of cultivated plants in the Argentine Republic.]—*Revista Fac. Agron. y Vet.* [B. A.], iii, 3, pp. 227–274, 4 figs., 1921.

This brings up to date the account of parasitic fungi found on cultivated plants in the Argentine Republic published by the senior author in 1914 (Hauman-Merck, L., 'Les parasites végétaux des plantes cultivées en Argentine et dans les régions limitrophes'. *An. Mus. Nac. Hist. Nat. B. Aires*, xxvi, pp. 163–225). It includes notes on the symptoms, treatment, and distribution of the various diseases, together with bibliographical references. One hundred and ninety-five diseases (including those caused by bacteria) are dealt with, followed by a brief description of one algal and seven phanerogamic parasites. The account terminates with a host-index and bibliography.

JANCHEN (E.). **Der Kartoffelschorf.** [Potato scab.]—Reprinted from *Oesterr. Zeitschr. für Kartoffelbau*, i, 3–4, 1921.

The author states that though true wart disease of potatoes

[*Synchytrium endobioticum*] has not yet appeared within the present limits of Austria, the less serious potato scab diseases have caused some alarm amongst growers who are not always able to distinguish them from wart disease. Scab is not responsible for more than a superficial injury to the tubers, but disfigures them and reduces their market price.

Basing himself on Wollenweber's monograph (Der Kartoffelschorf. *Arb. Forschungsinst. Kartoffelbau*, 2, 1920), the author distinguishes the following varieties of scab in Europe. 'Shallow scab' ('Flachschorf'), due to *Actinomyces tricolor* Wr., *A. intermedius* (Krüg.) Wr., and *A. nigrificans* (Krüg.) Wr. (the last two also attacking beetroot); 'deep scab' ('Tiefschorf') caused by *A. incanescens* Wr., and 'knobby scab' ('Buckelschorf') caused by *A. aerugineus* Wr. Other species that can cause scab of potatoes are *A. xanthostroma* Wr.; and *A. albus* (R. D.) Gasp., with its varieties *ochroleucus* (Neuk.) Wr. and *cretaceus* (Krüg.) Wr., the last named also attacking beetroot. Some of these species are also probably responsible for scab in carrots.

In addition to the scabs caused by species of *Actinomyces* there is another form, the spongy, powdery, or corky scab due to a different organism, *Spongospora subterranea* (Wallr.) Johns. (*S. solani* Brunch.), which does more damage as it penetrates more deeply, and can even cause the destruction of large portions of the tuber.

The characteristics of the different scabs are described. In shallow scab light-brown areas, rough, and as if covered with cork dust, appear on the surface of the periderm. The spots are generally small and round, but in severe cases may coalesce into larger areas. Torn pieces of the epidermis generally cover the roughened surface. Deep scab is distinguished by pits formed in the skin owing to the destruction of a portion of the periderm. These pits have an irregular, rough surface, and are often covered with scale-like remains of the dead tissues. By coalescing, shallow pits of larger extent may be formed, but infection never penetrates really deeply into the tuber. Knobby scab is characterized by small, slightly rounded or hemispherical protuberances, surrounded by torn pieces of skin, which arise as the result of an abnormal stimulation of the outer tissues of the tuber by the parasite. This is the form that is most liable to be mistaken for the early stages of wart disease, but it can be distinguished by the swellings never exceeding 1 cm. in diameter and having a smooth or slightly roughened, never an irregularly serrated or cauliflower-like surface. It is of less frequent occurrence than the others.

It is stated that *Actinomyces* scab is generally found on alkaline soils, *Spongospora* scab on those that are somewhat acid. Dry sandy soils favour the former, and dry years are generally also favourable to it. The different forms do not, however, react in exactly the same way to these factors.

Control measures have not generally given satisfactory results. Scab is chiefly a soil-borne disease, transmission by infected seed tubers being of very secondary importance. In scab-infected soil a three or four years' rotation or the planting of resistant varieties is recommended. The following resistant varieties are mentioned: Helios, Hindenburg, Jubel, Lucya, and Topas. These are also

highly resistant to wart disease. Susceptible to both wart and scab diseases are Alma, Ella, Goldspende, Nero, Imperator, Industrie, Johanna, Magnum Bonum, Primel, Schladener Ruhm, Silesia, Up-to-date, and Westfalia. Resistant to scab, but susceptible to wart disease are Deodora, Prof. Gerlach, and Geheimrat Haas, while the contrary is the case with the variety Juli and some others. In the case of *Spongospora* scab, liming the soil is recommended, while the use of acid fertilizers (ammonium sulphate and superphosphate) together with green manuring is advised for *Actinomyces* scab. Disinfection of the tubers with corrosive sublimate or formaldehyde is sometimes advisable, especially when opening new potato fields.

LYON (H. L.). **Three major Cane diseases: mosaic, sereh, and Fiji disease.**—*Bull. Expt. Stat. Hawaiian Sugar Plant. Assoc.*, Bot. Ser. iii, 1, pp. 1–43, 4 pl., 27 figs., 1921.

MOSAIC. This disease, which the writer identifies with that known for many years in Java under the name 'gele strepenziekte' (yellow stripe disease), is widely spread in Hawaii, Porto Rico, Louisiana, Florida, Cuba, Jamaica, Trinidad, and Barbados, while there are indications that it has been present for at least twenty years in Argentina, where it is now of general occurrence in the cane plantations.

The primary and critical symptom, and the only one on which a diagnosis should be based, is the appearance on the leaves of patches or blotches of a green colour several shades lighter than the normal green tissues which surround them. These blotches are most distinct when the leaves first unroll from the terminal bud (spindle), so that the newly-opened leaves should be the first to be examined when seeking evidence of the presence of the disease. The green tissues of the leaf-sheath are affected in the same manner as those of the leaf-blade, but the blotches are always less conspicuous. Mosaic does not, as a rule, induce an appreciable change in the size or shape of the leaves, but stunted shoots of affected Striped Tip sometimes terminate their efforts to grow by producing a few twisted and distorted leaves, giving them the aspect of canes about to succumb to Fiji disease. While some varieties of cane may carry mosaic year after year without showing any symptoms except the mottling of the leaves, others develop very marked secondary symptoms, one of the most frequent being the mottling or marbling of the stem; in varieties with a green rind the blotches develop strong red and purplish tints, while in canes with a normally red or purple rind the mottling is the result of a diminution or loss of the normal colours, the blotches appearing green on a dark background. The cankering of the stem observed in Porto Rico is, according to the writer, only an extension of the mottling of the rind to a point which results in the death of the affected tissue; the cracks or cankers thus formed in the rind afford easy entrance to various fungi which attack and destroy the soft tissues within the stem. In Hawaii, however, no case of similar cracking has yet been observed.

In a few varieties the disease affects strongly the growth of the plant, which may produce small and deformed canes or no canes at

all. This symptom is common in the Striped Tip and Yellow Caledonia varieties in Hawaii.

As a rule, mosaic does not by itself cause any marked change in the internal tissues of the stem. In canes long affected, however, there may sometimes be found irregular masses of internal tissue which are more or less stained and discoloured, ranging from light red to a very dark brown or almost black.

Despite much careful investigation, the writer and his associates were unable to locate by microscopic examination or cultural methods, any organism in canes affected with mosaic which might be responsible for the disease. Numerous experiments carried out on a highly-susceptible variety in the field with a view to conveying the disease by artificial means from affected to healthy plants, gave but a low percentage of positive results, which were furthermore invalidated by the natural spread of the disease in the plots used as checks. In the few experiments where canes grown in tubs and carefully isolated in a glass-house were employed, only negative results were obtained. Most of these attempts were made with juices extracted by pressure from affected canes, especially from near the growing point. The characters of the disease indicate that the causal factor operates at or near the growing point. The actual injury to the chlorophyllous tissue is accomplished while the leaf is still rolled up in the spindle.

According to the author's observations, mosaic is not induced in the sugar-cane either directly or indirectly by soil conditions; it is not transmitted through the soil, and does not hold over in the soil from one planting to the next. If a diseased stool is removed and a healthy cutting is planted in its place, the latter invariably gives rise to a healthy stool which will remain healthy throughout several seasons unless reinfected from outside. The author cites the case of a large field where over 90 per cent. of the canes were diseased; the field was cleared of the diseased stools and replanted with healthy cuttings, which produced a stand of canes in which the disease never appeared.

The progress of the disease in individual cane stools would seem to indicate that the causative agent does not migrate to any extent, if at all, through the tissues of the stem from one shoot to the next, but that the infection usually spreads by an aerial route from shoot to shoot, even in the same stool. In almost all cases when a leaf is mottled the corresponding eye will contain the infection, and any shoot developed from it will show the disease. But cuttings from parts of diseased stools which bear unmottled leaves may give perfectly healthy canes, and it is even possible to get healthy ratoons from stools in which every shoot has shown the disease.

No cane variety grown for sugar production in Hawaii is immune to mosaic, but some varieties are so very resistant that for practical purposes they may be considered immune. Striped Mexican, Badila, and Demerara 1135 are the best canes in this class. Yellow Caledonia is only moderately resistant, while Lahaina, Striped Tip, and Demerara 117 are very susceptible. Seedling canes are almost invariably as susceptible as are their parents. The variety known as Kavangire, which is only another name for Uba, is unsuitable for sugar production in Hawaii, but is stated elsewhere to be

immune. The true Cavengerie, on the other hand, is very susceptible.

It should be held axiomatic that mosaic lessens the sugar manufacturing capacity of the plant. The losses caused by it vary according to the variety of cane grown. In Striped Tip the plants can be rendered utterly worthless. Even in Lahaina, which carries the disease without showing marked evidence of injury, actual tests made by the author showed that the stools from diseased cuttings yield only 60 per cent. as much sugar as stools from healthy ones.

Mosaic can be controlled only by the use of resistant varieties and by planting cuttings from none but healthy canes (if possible from disease-free fields) carefully selected by an experienced staff. When the attack is limited, it should be eliminated at once by removing and destroying all affected canes.

SEREH. Sereh is believed to be an infectious disease. but so far the causative agent has not been determined. It suddenly appeared in West Java in the early eighties of the last century, and it has since been reported from Borneo, Sumatra, Malacca, India, Mauritius, Australia, Formosa, Hawaii, and Fiji. Some of these reports however, were based on insufficient evidence or a mistake in the diagnosis. Thus the author is satisfied from personal investigations that the Fiji report was incorrect, and also that the Hawaiian condition formerly attributed to sereh is not that disease.

In some varieties of sugar-cane (e.g. Cheribon), sereh arrests the growth of the canes, the majority of shoots remaining short and stunted, and the whole stool assuming the aspect of a tuft of lemon-grass (the native name for which in Java is 'sereh'). In other varieties, as for instance 247 B, the growth of the affected canes is not impaired, these growing as rapidly and to the same length and diameter as the healthy ones, but being much lighter in weight and yielding far less juice and sugar. The tissues inside diseased stalks usually contain vascular bundles of a red colour, due to the presence of a red gummy substance in the vessels; these are not very conspicuous in Cheribon, and are hard to find until after the shoots are ten months old. In 247 B, on the other hand, they are numerous, and constitute the one critical symptom on which a certain diagnosis can be based. In certain varieties (e.g. 247 B), diseased canes develop copious adventitious roots which grow under the leaf-sheaths from the aerial nodes. An additional symptom may consist in a lack of sap in the central tissue of the internodes, which is then white and strongly resembles an axillary strand of pith. In the older internodes near the base of the cane, this pithy central tissue often breaks down, leaving a cavity of considerable size. Of late years it has been shown that the failure of a cane, the leafy top of which has been removed, to produce lateral shoots from its upper eyes is a direct evidence of the presence of sereh.

Experience in Java has proved that cuttings obtained from canes affected with sereh invariably give rise to badly diseased stools, and the symptoms are always more pronounced in each succeeding generation. The practice of ratooning had also to be abandoned there, as the stands thus obtained showed such an increase of the disease as to render them valueless.

Measures for the control of sereh are limited to the use of resistant varieties, mostly seedling canes (none of which, however, according to the author, combines really high sugar-producing properties with immunity to sereh), and to planting cuttings obtained from healthy canes. It was early noticed that the disease did not flourish at high elevations, but was confined to the lowland fields. This led to the development of the well-known hill nursery system in Java. The canes for seed are first grown at an elevation of 5,000 to 6,000 feet, and cut when six to eight months old. The cuttings are used for planting secondary nurseries at 2,000 to 2,500 feet, and the cane from these is again used to plant nurseries at about 1,000 feet, from which the seed for the plains is obtained. At each stage a rigorous selection is practised, and if proper care be taken to exclude all affected cuttings it is only necessary to renew the stock from the mountains every four or five years. Even without the use of mountain seed some plantations in Java manage to keep the disease under control by selection of disease-free cuttings from their own fields.

Fiji disease. After a very full description of the disease [see next abstract], based on material obtained from Fiji and Australia and field observations in the former locality, the writer states that during the past year he has turned all his material over to Dr. L. O. Kunkel for further study. At the present time, all that can be said regarding the organism held to be responsible for the disease (for which the author proposes the name *Northiella sacchari*) is that it is always present in all of the stem and leaf galls of canes affected with Fiji disease; that it has been found in incipient galls only three millimetres below the growing point of the cane stem; and that in developing galls the individual organisms have been observed to divide simultaneously with the nuclei which they accompany. The author also states, basing himself on the discovery of Fiji disease in New Guinea in 1914, that the disease, which was considered as endemic in Fiji, may well have been imported there from New Guinea with some of the many cane varieties which have, from time to time, been taken from there for purposes of cultivation on the sugar estates of Fiji and Australia. The New Guinea cane variety Badila was noticed at an early date to be exceptionally resistant to the disease, and recent information indicates that it is still the favourite cane in Fiji, where, up to the present, no more resistant variety has been found. The sugar industry at Fiji, at one time gravely threatened by this disease, is now thriving. This is due not only to the use of resistant varieties and the selection of healthy cane for seed, but also to the system of rotation followed. As a rule, only first ratoons are taken, and then the land is kept under beans for a year before again planting cane. The disease is rare on poor soil, and cane grown on such soil is largely used for seed.

Reinking (O. A.). **Fiji disease of Sugar cane in the Philippine Islands.**—*Phytopath.*, xi, 8, pp. 334–337, 2 pl., 1921.

The Fiji disease of sugar-cane has been present in the Philippine Islands since at least 1916, but no authenticated report of its presence was given until December 1920, when the author made an

examination of the infected fields and found that the disease was extremely destructive, especially to imported varieties such as Java 247 and Hawaii 109, the losses amounting in some cases to 50 to 75 per cent. Indigenous varieties (Cebu Purple, Lamao White, Negros Purple) were much less severely affected, even when growing intermingled with heavily infected Hawaiian or Java varieties; the use of these canes, combined with crop rotation in the fields, would therefore appear to be an effective method of control of the disease in the Philippines. It has not been observed on the wild sugar-cane (*Saccharum spontaneum*).

The most constant symptom of Fiji disease, and the only one in the early stages of infection, is the occurrence of elongated, raised galls extending lengthwise on the under side of the leaves, either on the main vein or on the smaller veins, and varying in length from 2 mm. to 6 cm. or more. The young galls are of a lighter green than the normal tissue of the leaf, and are translucent if the latter is held up to the light. Later they become much thickened, opaque, frequently turning reddish in spots, then brownish, and in some cases may burst open, exposing a brownish mass. They do not extend through the leaf, there being only a slight yellowing on the upper surface to mark the position of the gall below. In advanced cases galls may also be found on the leaf sheaths, but they have never been observed on the stems of the canes; they are present in abundance on old dead and dried leaves, which may be a source of infection.

Badly infected plants remain small and stunted (owing to the shortening of the internodes) and have a bunchy growth of leaves at the top. An excessive number of shoots is developed, and the leaves produced are small, slender, and of a darker green than normal; this darker colour is present even on canes that have been affected apparently for a few months only; otherwise, in the latter case, the appearance of the sugar-cane is normal except for a slight stunting, more upright leaves, and the production of galls.

In diseased plant canes, the root system is small, bunchy, and slightly rotted; in diseased ratoons it is also smaller and more decayed than ordinarily. A rot may extend from the dead roots into the stem, though it is not always associated with this disease, and appears to be a secondary trouble caused by some organism that attacks the weakened canes. New shoots arising from the base of diseased plants often have a yellow streak running down the central group of unfolded leaves; in advanced cases these shoots may be rotted and the diseased condition may extend for a short distance into the stem. The shoot rot is characterized by a yellowing of the exposed leaves and a subsequent reddening of the young rolled-up leaves within the sheaths. The leaves finally die, and the entire inner part of the shoot is affected by a soft brown rot. These conditions are probably due to the attack of secondary organisms, the disease being sometimes not accompanied by rotting. Usually there is no discoloration of the interior tissues of the canes of diseased stools except at the nodes where a shoot arises, and just above the root system; at these points a yellowing or reddening of the tissues may be present. In a few cases entire canes, from the roots to the top, have been observed to be somewhat pithy and

soft, without showing any discoloration or decay; the tops of such plants are very bunchy, and numerous galls are present on the leaves.

Frequently in plant canes one stalk of a stool is visibly diseased, while the rest appear to be unaffected; it is reported, however, that tops taken from such apparently healthy stalks will carry infection.

Plasmodia-like bodies are found in young and old galls; they are light-coloured in the former, brownish and more granular in the latter. These bodies occur also in the cells of the young shoots that arise from the base of diseased plants. Other bodies of a fungoid nature are present in the rotted roots and base of the stem; this would indicate that a fungus is responsible for the disease, but it will be necessary to establish the connexion by isolation and inoculation experiments before it can be accepted. At present, all indications tend to show that the causal factor gains entrance to the plant through the root system, and that it may remain in the soil for at least a year.

The constitution of the soil appears to have no influence on the disease, which attacks susceptible varieties with equal severity on heavy clay and lighter loam soils. It is always more severe in ratoon than plant canes.

ASHBY (S. F.). **The mosaic, mottling, or yellow stripe disease of Cane.**—*Leaflet Dept. Agric. Jamaica*, 13 pp., 1 pl., 1920 [Rec. June, 1921].

The mosaic disease of sugar-cane has been recently found to be rather widespread in Jamaica. Its symptoms [see abstract p. 184] are described in detail. In cases of secondary infection the first leaf affected has few of the pale green marks, and these are mostly near the base of the blade or close to the midrib, but each successive leaf shows an increase in the number. If the infection is primary, an additional symptom usually occurs in the form of white opaque flecks or stripes on the pale patches; these perfectly white stripes are long (up to several inches) and usually very narrow, but may become broader by fusion. While the light or yellowish green patches may sometimes disappear on older leaves owing to partial regeneration of the normal ground tint, the white stripes and flecks undergo no change. This white striping of the leaves in primary infections has not been reported from Java and Hawaii, although it is present on all affected varieties in Jamaica and apparently also in Porto Rico. The red or yellow stripes that appear on the stems of affected canes (the former on varieties with yellow stems, the latter on the red-stemmed canes) are most marked on the younger joints protected by the leaf-sheaths; on the older joints exposed to light the development of the natural colour masks the effect. Where the infection is primary, similar white markings to those found on the leaves frequently occur and persist even on the older joints. Affected canes show a tendency to split along these white stripes, and the stem cankers already reported from Porto Rico are caused in this way, the underlying tissues becoming browned or reddened. In Hawaii and Java similar cankers have not been observed.

No micro-organism capable of causing the disease has been

isolated from affected canes, but the disease may be regarded provisionally as due to an ultra-microscopic organism. Attempts to infect healthy leaves of sugar-cane by rubbing them with crushed diseased leaves have usually failed, but as far back as 1902. Kamerling in Java claimed to have transmitted the disease by injecting sap. The work of Brandes (*Journn. Agric. Res.*, xix, pp. 131–138 and 517–521, 1920) has recently shown that insects can carry infection, *Aphis maydis* having been proved to carry the infection from sorghum to cane and vice versa, and the sorghum mosaic derived from cane being transmissible to maize by the same insect. It has been stated that the disease was noticed to spread more rapidly in Porto Rico during and following an abundant infestation of leaf-hoppers (*Tettigonia* sp.), and also it is probable that the cane-fly (*Stenocranus saccharivora*), very abundant at times in Jamaica, may be an active carrier of the disease.

There is conclusive evidence that sugar-cane plants can become infected in two ways, which the author distinguishes as primary and secondary infection. Primary infection is derived from the use of tops or cuttings from infected canes, the disease being conveyed in the seed-piece. It is not definitely known whether it can be equally conveyed in the true seed, the evidence so far being negative. Secondary infection results in the appearance of the disease in growing healthy shoots, the infection occurring near the growing point, and every successive leaf, joint, and eye subsequently developed showing the disease. If the infection occurs when the cane is some months old several of the oldest leaves and the corresponding eyes and joints will be free from the disease and the upper part only of the stalk is affected; in such a case the tops will transmit the disease if used as seed-pieces, while the lower joints may give rise to healthy plants and ratoons.

Convincing proof that secondary infection is air-transmitted and may be very active is of rather recent date. The author cites a number of observations and experiments by various workers bearing on this type of infection. It has been noticed that active secondary infection may be quite transient, or may be permanently rare in some localities, and that spread may be much more vigorous on cane planted at certain times of the year than at others. There is no very definite knowledge as to the influence of weather and soil on the intensity and persistence of secondary infection, though it has been stated in Java that sound seed-pieces from cane grown on light land produced plants which contracted infection more readily than plants from seed-pieces cut from cane grown on heavy soil, and also that weather conditions may at times strongly influence secondary infection, plants cut back during the rainy season frequently showing a marked increase of mosaic on the new growth.

Observations in Jamaica show that serious reduction in the tonnage of the crop results from the disease, actual tests indicating that complete infection might cause losses of from 6 to 48 per cent. The yield of juice in severe cases is also reduced, and its composition may be affected adversely. Of the thick varieties grown in Jamaica, B 208, B 6450, and Poaole (the same as the Hawaiian Cavengerie) endure the disease badly. Apparently none are im-

mune, although Ribbon and Transparent are more endurant than those last mentioned. The resistance may vary appreciably in the same variety in different regions and on different types of soil under similar climatic conditions. On the other hand, mosaic does not appear to have been reported on any of the thin varieties, and the thin Uba cane (Kavangire of Porto Rico and Argentina, not to be confused with Cavengerie) has proved to be immune in Jamaica as elsewhere. Under favourable conditions it yields as heavy a tonnage as any known thick cane and ratoons well.

The measures adopted for controlling the disease depend on certain well-established facts: (1) The disease is always transmitted in seed-pieces cut from affected stalks; tops from such canes always carry the disease, but in cases of late secondary infection the lower parts of the cane may be free from the virus and give healthy shoots when used for planting. (2) Infection can be transmitted by aerial agencies from diseased to healthy plants. (3) Infection is not retained in the soil. They consist in the selection of tops and cuttings from healthy plants and in the eradication of diseased plants from the young plant and ratoon fields. The latter measure is the more practicable if the amount of disease does not exceed 20 per cent.; beyond this limit roguing out is not done, as the loss arising from an uneven stand and the expense of supplying will probably exceed the immediate loss from disease. It is of much importance that the inspection of the young plants be made as early as feasible in order to get rid of all primarily infected shoots which may act as centres of secondary infection if left. A second inspection should always be made three to four weeks later. Young ratoons should be treated in the same way, and the affected shoots should be dug out and chopped up so that no further growth can occur. If a heavily infected ratoon field is replanted with sound seed, the old stumps should be destroyed and not left half buried.

B(ARBER) (C. A.). **The mosaic or mottling disease of the Sugar-cane. The main facts of the case to date.**—*Intern. Sugar Journ.*, xxiii, pp. 12-19, 1 pl., 1921.

A summary of the literature, especially the discussion in the pages of the *Louisiana Planter* in 1919-20, regarding the damage that mosaic is capable of causing to the sugar-cane, is given. While in Hawaii and Porto Rico the losses are very serious, Cuban experience is the reverse, Grey (*Louis. Plant.*, Aug., 1919, p. 90) stating that it does no damage in that island, and that it can be eliminated by improved cultural methods. In the Argentine also, though mosaic is of long standing there, and though Fawcett (*Louis. Plant.*, Jan., 1920, p. 39) found better cultivation had no effect and considers the disease incurable, it does little harm to the cane varieties now grown, most of which are thin kinds. In Java it has been recognized as causing appreciable loss, but is apparently controlled by the continual planting of sound seed; it is suggested also that the disease was, in any case, less virulent in Java than the later outbreaks in the New World, possibly because the Java canes had acquired some degree of resistance from their long cultivation in the presence of the disease. In San Domingo the disease is widely distributed, but does not assume the severe form found in Porto

Rico, and stem infection has not been observed. In this locality and also in Cuba it has been suggested that growth on virgin soil may have something to do with the relative mildness of the disease. In Cuba secondary infection seems to be rare, and transmission only through diseased sets makes it difficult for the disease to hold its own.

The thin varieties of Argentina are mostly Java seedlings with North Indian blood in them of the Saretha group of canes; they are not in the least immune, but the effect of the disease is slight, and perfectly good yields may be obtained from fields with 100 per cent. infection. The Uba and so-called Japanese canes which are immune or resistant possibly all belong to the Indian Pansahi group. Neither of these classes can be recommended for growth in typically tropical areas, and unfortunately all the well-known canes of commercial value and multitudes of seedlings suitable for tropical cultivation are susceptible, over 1,000 kinds having been tested. The degree of susceptibility, however, varies, and some of the Louisiana canes are especially mentioned as being particularly hopeful in this respect.

The influence of local conditions is apparently considerable, and is, the author thinks, deserving of fuller investigation. There is the strongest evidence that insects of the sucking kind, often powerful flyers, are concerned in the spread of infection in the field. The period of incubation in secondary infection appears to be from two to three weeks, and the disease appears within six weeks or two months of planting.

Reference is made to the similar mosaics of other cultivated cereals and grasses, especially to the work of Brandes in showing that sorghum, crab-grass, foxtail, and a species of *Panicum* became infected when enclosed in a greenhouse with diseased sugar-cane. The possibility that wild grasses bordering cane-fields may act as sources of infection is a very serious one when measures of control are contemplated. The control of the disease is stated to be in advance of our scientific knowledge of its character, and depends primarily on eradication, seed selection, and the use of immune or resistant varieties. The results of the eradication campaign in Porto Rico are stated to have been eminently satisfactory.

WILLIAMS (C. B.). **Sugar-cane pests and diseases in Trinidad in 1920.**—*Bull. Dept. Agric., Trinidad and Tobago*, xix, 3, pp. 111–121, 1921.

The mosaic disease was first discovered in Trinidad at the beginning of 1920, and was then confined to an area around the Government Experiment Station at St. Augustine and about forty isolated localities throughout the island. There was evidence at first that it had been introduced through St. Augustine, but subsequently another estate was found to be heavily infested both in nursery plants and old ratoons, indicating that the disease had been present for several years at least and suggesting a second point of introduction.

The visible effect of the disease on the health and growth of the plant varies considerably in different varieties, and is most distinct in cases where the plants have been grown from infected

cuttings; in some varieties the infected plants are without exception small and stunted, and may be less than one quarter of the average size of the healthy plants, while in other varieties the difference is scarcely noticeable. A table is given of the effect on a number of varieties grown.

Many other plants in Trinidad have, at times, mottled leaves closely resembling mosaic, but the sugar-cane mosaic has so far only been found on maize and one local species of grass. The presence of the mosaic on maize, although making the extermination of the disease more difficult in the wet season, is not very serious in itself, as no maize is grown for at least three months in the dry season, so there is no danger of its carrying the disease on from one season to the next.

Observations during 1920 indicated that there was practically no spread of the infection from diseased to healthy plants during dry weather. There are indications that spread is in some way connected with moisture, and on one estate the greatest spread was found to have occurred along the banks of a small river; in another case, where the infected stools were placed in long beds running down a slope, and across a small flat moist area at the bottom of the slope, the original infection was evenly distributed on both slope and flat, but the secondary infection was considerably greater on the latter than on the former.

There now seems to be no doubt that the disease is spread chiefly, if not entirely, through the agency of insects, but in Trinidad the insect carrier is unknown. The author did not see leaf scale, aphids do not seem to exist on the sugar-cane, and the cane-fly (*Stenocranus*) is extremely rare. Experiments made with the frog-hopper (*Tomaspis saccharina*), corn leaf-hopper (*Peregrinus maidis*), cane leaf-hopper (*Tettigoniella laudata*), and a cane membracid (*Ceresa vitulus* F. var. *minor* Fowl.) failed to give any conclusive results. The only other common insect in the fields which seems sufficiently abundant to account for the spread is the mealy bug, and experiments with this are proceeding.

Field experiments also failed to establish the occurrence of infection through the soil, and the author concludes that there is little or no danger of infection by replanting in old holes from which diseased stools have been removed.

Contrary to the general statement that all cuttings taken from a diseased plant will reproduce the disease, the author proved by experiment that quite healthy cuttings which do not carry the disease can be obtained from canes recently infected at the top, if the cuttings are taken far enough from the infected point. In field infections the cane becomes infected from the growing point or leaves, and it takes an appreciable time for the disease to descend the stalk to the ground level. The spread from one stalk to another in a stool is still slower, and in many cases does not occur at all, so that cane stools may be frequently found with one stalk well infected and the others healthy. Experiments are now being made to find out whether it might be possible in some cases to prevent the infection from spreading to the underground part of the stool by cutting off the recently infected stalks close to the ground, as it would then be possible to keep mosaic disease under control towards

the end of the year by a more frequent removal of the diseased shoots without the costly and wasteful eradication of whole stools. Experiments are also planned to test the possibility of poisoning the diseased shoots when cut to prevent new growth from these portions of the stool.

Control work was started as soon as the disease was identified, but during the wet season it soon got out of hand. In certain districts, however, it has been greatly reduced. A new campaign, for which £3,000 was voted, was planned for the dry season of 1921. Eradication of diseased stools is the method adopted.

CAUM (E. L.). **A contribution to a check-list of Sugar-cane fungi.** —*Bull. Expt. Stat. Hawaiian Sugar Plant. Assoc.*, Bot. Ser., iii, 1, pp. 66–97, 7 figs., 1921.

The author has made an attempt to list all the fungi which have been reported on *Saccharum officinarum*, either as parasites or saprophytes, in any part of the world. The parasites and saprophytes are distinguished, and synonyms and bibliographical references to the original descriptions are given. Figures and diagnoses of *Lophodermium sacchari* Lyon (*Hawaiian Plant Rec.*, ix, p. 601, 1913) and *Phyllosticta hawaiiensis* Caum (ib., xx, p. 278, 1919) are included. The list terminates with a general classification of sugar-cane fungi.

KUNKEL (L. O.). **A possible causative agent for the mosaic disease of corn.**—*Bull. Expt. Stat. Hawaiian Sugar Plant. Assoc.*, Bot. Ser. iii, 1, pp. 44–58, 12 pl. (one coloured), 1921.

The symptoms of the disease as indicated by mottling or striping of the leaves, leaf-sheath, and rind, and the dwarfing of the plant, due chiefly to shortened internodes, are described; and the occurrence of elongated pockets within the tissue of the stalk, distinguished at first by a water-soaked appearance and later by a pale yellow or brown colour, is reported. At an advanced stage the cells of these pockets collapse, and elongated cavities are left within the stalk. A number of varieties of maize were tested for resistance to the mosaic, and the following showed lesser infection and appeared to be somewhat resistant: Sweet corn: Country Gentleman, Stowell's Evergreen, Adam's Corn; Field corn: St. Charles White, Lancaster Surecrop, White Guam, Yellow Guam, Cuban Red, Hybrid No. 1415, and U.S. Selections Nos. 77, 120, and 125; Pop corn: Queen's Golden and White Rice. The following varieties suffered severely from the disease: Sweet corn: Cosmopolitan, Black Mexican, Early Fordhook, Burpee's Earliest Catawba, and Golden Bantam; Field corn: St. Charles Yellow, Commercial White, Reid's Yellow Dent, Boone County White, and U.S. Selection No. 119.

Diseased and healthy tissues of maize plants were studied cytologically, and intracellular bodies, believed to be living organisms, were found invariably to be present in most of the diseased cells, and to be absent from healthy tissues. In the leaves the intracellular bodies occur in the leaf tissue of the lighter green areas, while in the stalk they are found in the elongated pockets above described. These bodies vary greatly in size and shape. They

appear to increase in size as the diseased condition of the cell becomes more severe. They are never spherical, but irregular and amoeboid, and they are always on or near the host-cell nucleus. When the body is not lying against the nucleus, it may be connected with the latter by a thin, veil-like appendage. A thin membrane may surround these bodies, although they usually appear to be naked. The contents may be reticulated or made up of strands, and at a late stage small granules are scattered in the reticulum. No nucleus was demonstrated, though deeply staining granules are often present which might possibly be nuclei. There may be a single large or many small vacuoles, or sometimes none at all. The best results were obtained from fixing the tissue in Flemming's weaker solution and staining with Flemming's triple stain.

Studies of free-hand sections of living tissue showed that the host-cells are in a state of great protoplasmic excitation. The intracellular bodies were not seen to show independent movement. The host-cell nucleus may enlarge greatly, and the cell itself also usually enlarges. Diseased cells may die, as in the case of the cavities in the stalk. The presence of intracellular bodies is more difficult to demonstrate in the leaf tissues than in those of the stalk, but they are nevertheless present in the leaves quite as regularly as in the stalk. All tissues of the leaf and stalk may contain them, but they have not been found in the grain or in the roots.

The yellow-stripe (mosaic) disease of sugar-cane is considered to be similar to or identical with the corn mosaic. A granular substance such as found by Matz (*Journ. Dept. Agric. Porto Rico,* iii, pp. 65–82, 1919) in discoloured cells of yellow-striped cane was also found by Kunkel in cane and corn stalks affected with mosaic, but was considered to be different from any stage of the intracellular bodies above described that the author has seen, and he is unable to suggest what relation it may have to these diseases.

The intracellular bodies are considered to be possibly similar to such structure as the Negri bodies (*Neuroryctes hydrophobiae*) found in animals affected with rabies, and with *Cytoryctes variolae* found in the skin cells of man and apes affected with small-pox. Though these bodies have not been cultured, and there is no definite proof that they are etiologically related to the diseases they accompany, nor even that they are living organisms, they are believed by some to be protozoa.

KUNKEL (L. O.). **Amoeboid bodies associated with Hippeastrum mosaic.**—*Science,* N.S., lv, p. 73, 1922.

The occurrence of bodies similar to those found in the cells of corn affected with mosaic [see preceding abstract] is reported in the light green portions of mosaic leaves of *H. equestre* Herb.

DASTUR (J. F.). **Die-back of Chillies (Capsicum spp.) in Bihar.**—*Mem. Dept. Agric. India,* Bot. Ser., xi, 5, pp. 129–144, 2 pl., 1921.

Die-back is caused by *Vermicularia capsici* Syd. The disease appears about the latter part of September or beginning of October in Bihar (India) in seasons of high humidity. Late sown plants,

and plants growing under shade, were found to be affected only slightly. The fungus commonly attacks the stem at the growing point or the flower-bud, and the plant dies back as the attack spreads downwards. The infected part of the stem assumes an enamelled white appearance, sharply defined from the healthy part by a black line. The fruits are also attacked, the attack being visible usually only when they turn red, and rarely appearing on those that mature after the beginning of December; black spots, which may turn greenish or greyish, develop, badly diseased pods becoming eventually straw-coloured or whitish. The spots are covered with acervuli and stromata. The fungus penetrates as far as the seeds, the hyphae entering the seed-coat by boring their way through the outer cellulose wall, without necessarily forming an appressorium. They then pass through the cavity of the cells, and swell up at the point of contact on the thickened cellulose and lignin inner walls. A fine process is put out from the swelling which bores through the wall, delignifying it. The fungus will remain alive within the seed for at least a year, and when the seed germinates the embryo may be killed, or may develop into a diseased plant, or even into a healthy plant in dry weather. The microscopic details of the attack on different parts of the plant, and of the formation of the fructifications are given.

The fungus was cultured, and its appearance in culture is described. No perithecial stage was found. Inoculation experiments resulted in infection of seedlings under moist conditions, and growing points and flowers were also infected. The success of the inoculations and the spread of infection depended on the amount of moisture in the air, a very high degree being required. From field observations it appears that an average relative humidity of over 85 per cent. is necessary to cause serious damage. Mature fruits were readily infected, but not green fruits. The fruit may become infected by the hyphae themselves passing through cracks in the cuticle; or processes from the hyphae may bore directly through the latter, an appressorium being always formed in this case. Infection was also brought about on seeds by inoculation, no appressorium being formed. Flowers of *Carica papaya* were infected by artificial inoculation, and a certain amount of infection was brought about in pods of *Vigna catjang* and *Dolichos lablab*, and in fruits of *Solanum melongena* and *Citrus* sp. Inoculations of *Mangifera indica*, *Musa* sp., *Phaseolus vulgaris*, *Lathyrus odoratus*, *Allium cepa*, *Saccharum officinarum*, and *Sorghum vulgare* failed.

Seed selection from healthy pods did not prove practicable in controlling the disease under field conditions. The use of fertilizers (especially forcing manures on late sown crops) or of shade may prove to be valuable in lessening the loss. Two applications of a one per cent. Burgundy mixture reduced the percentage of diseased fruit considerably, and the sprayed plants had decidedly less die-back. Spraying also prevented subsequent loss from the development of the fruit rot in store.

The occurrence of *Choanephora cucurbitarum* (B. & Rav.) Thaxt. (see *Ann. of Bot.*, xxxiv, p. 399, 1920), on chillies is again recorded. Shaded and late-sown crops suffered less from this disease, as in the case of the *Vermicularia* disease.

EDGERTON (C. W.) & MORELAND (C. C.). **Eggplant blight.**—*Louisiana Agr. Exp. Sta. Bull.*, 178, pp. 1–44, 18 figs., 1921.

The yield of eggplants (*Solanum melongena*) in Louisiana is usually reduced at least one-half by *Phomopsis vexans*, which causes the worst disease known in this crop. Leaf spots, fruit rot, stem cankers, and twig blight are produced, and also a damping off of young seedlings. These different types of the blight are fully described. The fungus is carried over winter on and inside the seed. The pycnidia are variable, the larger ones having sometimes more than one chamber or more than one mouth. They may produce spores of the *Phyllosticta* or of the *Phlyctaena* type, developed in the same or in different pycnidia. A species of *Diaporthe* occurs on dead stems of eggplant, which cannot be distinguished from *Phomopsis vexans* in pure culture, but which did not produce disease on inoculation. The disease may easily be produced after seven to nine days' incubation by inoculation with *P. vexans*. The fungus is able to penetrate the uninjured tissue of the host, but did not infect potato, tomato, pepper, or certain wild species of *Solanum*. The use of a 1–300 formaldehyde solution on the seed was found to reduce the amount of disease slightly, but not to eliminate it.

Certain varieties of eggplant are less susceptible to the disease than others. Of the three varieties commonly grown, Black Beauty, Mammoth Purple, and Florida High Bush, the last is much the most resistant. Rotation is absolutely necessary, as the fungus lives over from year to year very readily on fragments of old plants left in the field. Not less than a three years' rotation is recommended, and the old plants should be burned as soon as the crop is over.

It is doubtful if spraying will be found profitable, though when properly done it reduces the disease to some extent.

VUILLEMIN (P.). **Un nouveau champignon parasite de l'Homme, Glenospora gandavensis.** [A new fungous parasite of Man, *Glenospora gandavensis.*]—*Comptes Rendus Acad. des Sciences*, clxxiii, 7, pp. 378–380, 1921.

In a previous report (*Comptes Rendus*, cliv, pp. 141–143, 1912) the author gave the essential characters of the genus *Glenospora* Berk. & Curt., the species of which were formerly variously distributed among the genera *Stemphylium*, *Graphium*, *Cephalothecium*, and *Verticillium*.

A true fructification is not known. Propagation is ensured by the thallus, certain cells of which act as thallospores. The thallospores, detached by the breaking up of articulations, are arthrospores of the type characteristic of the Mycodermaceae. Some of them (*oidia*) are cells preserving the structure of the vegetative hyphae; the remainder are chlamydospores which accumulate reserves under their thickened membrane. The latter have been mistaken for conidia when they are terminal and more or less uniform, but conidia differentiate themselves from the thallus as soon as they appear and fall off naturally when ripe. The regularity of the terminal chlamydospores, which are besides connected by transitions with the polymorphous lateral and intercalary

chlamydospores, allows at the most of distinguishing them among arthrospores by the name of '*aleuries*'.

*Glenospora graphii* was previously known in diseases of the ear and of the cornea. In 1916 Chalmers and Archibald described *Glenospora khartoumensis* from mycetomas in the Sudan, and in 1917 *Glenospora semoni*, in France, on a soldier returned from India. A new species has just been discovered in a culture from Ghent, isolated by Prof. M. Henseval from the expectoration of a patient suffering from fetid bronchitis.

The '*aleuries*' of these four parasites of man are smaller than those of the plant parasites. In the latter they are 10 $\mu$ in diameter or more, while their average dimensions are 6 to $6{\cdot}7 \times 4$ to 5 $\mu$ in *Gl. graphii*, 4 to $5 \times 3$ to 4 $\mu$ in *Gl. khartoumensis* and *Gl. semoni*, and 6 to $10 \times 5$ to 8 $\mu$ in the Ghent species, which the author names *Glenospora gandavensis*.

The culture sent from Belgium was covered with a white dust with black spots, from which arose dark agglomerations, the largest of which measured 3 mm. The dust was found to be composed of cells measuring 8 to $13 \times 1{\cdot}6$ to $3{\cdot}5$ $\mu$ and resembling *Mycoderma*. The dark spots and agglomerations contained chlamydospores measuring 6 to $10 \times 5$ to 8 $\mu$ in which were refractive drops under a reddish-brown wall.

From the chlamydospores the colourless cells were obtained, and reciprocally. In all cases germination gave rise to hyaline hyphae which soon became septate and then broke into fragments. Branching took place only in a thick drop, in which aeration was bad; it began then at the base of the germ-tube as it issued from the chlamydospore, and extended in all directions.

The fungus grows well at temperatures from 20° to 37° C. with an optimum of 32° to 35° C. In weakly-aerated media (Veillon agar and the bottom of liquids) the hyaline, branched hyphae, without chlamydospores, predominate. In Veillon test-tube stab cultures nothing is to be seen in the superficial layer to a depth of 2 to 5 mm.; immediately beneath this sterile stratum the colony expands; below this expansion it shrinks again or is interrupted and reappears lower down in patches which grow smaller as the supply of oxygen diminishes. The fungus prefers slightly acid media, and itself increases the acidity. Cultivated on the surface of maltose agar the colony assumes, like *Gl. semoni*, the form of a black cupola with light-coloured fringes. On carrots the cultures blacken on about the fourth day; on the fifth day branched sporophores are found.

The chlamydospores have the same diversity of position and form as those of *Gl. graphii*. When they form at the end of several closely placed branches and their support shows one or two varicose swellings beneath them, they give the same appearance that led *Gl. graphii* to be included in the genus *Verticillium*. The intercalary chlamydospores may remain cylindrical and of the same diameter as the hyaline cells. The rounded chlamydospores in the neighbourhood of those formed terminally should not be mistaken for chains of conidia.

Hyaline cells of the usual size have been observed escaping as from a sheath through the truncated tip of a 4 $\mu$ thick hypha,

resembling the supposed endoconidia which form the slender basis of the genus *Chalara*. Such cells are, however, only a vegetative rejuvenescent form by which the arthrospores renew their wall and get rid of their old membrane.

SALMON (E. S.). **On forms of the Hop (Humulus lupulus L.) resistant to mildew (Sphaerotheca humuli (DC) Burr.)**—*Ann. of Appl. Biol.*, viii, 3–4, pp. 146–163, 1921.

The investigations into the resistance to mildew of 'wild hop' seedlings raised from seed obtained from Vittorio, Italy, which have been continued through seven seasons (1914–1920) and of which a preliminary account has been given in previous articles, have now been brought to a close.

In the course of greenhouse experiments carried out in 1920, the author found that 200 cuttings ('clone-plants'), which had been raised vegetatively from 23 different seedlings, remained wholly immune to the disease throughout, while 53 cuttings taken from 14 different seedlings showed susceptibility to it. 'Semi-immunity' in a more or less marked degree was observed in 20 clone-plants originating from 7 seedlings, of which one had not been tested before, while the remainder had given the same result in preceding seasons. The plants were in every case exposed to artificial as well as to almost constant natural infection, and the severity of the test can be gauged from the fact that all of the 63 cuttings of various commercial varieties of hops standing in the same greenhouse became naturally infected within three weeks. Of the 53 susceptible plants 34 were severely affected, and the mildew persisted on all of them until the end of the growing season. All the experimental cuttings were taken from the parent plants, growing in the hop-garden attached to Wye College, in the winters of 1917, 1918, and 1919, and it is important to note that cuttings taken in successive years never showed the slightest tendency to change from immunity to susceptibility, or vice versa. From the tests undertaken the fact emerges clearly that the differences in susceptibility shown by the particular seedlings are inherent and not brought about by special environmental influences.

In summarizing the results obtained during the full period of seven seasons, the author gives a detailed account of the behaviour of 52 seedlings, selected from 480, which is the total number kept under observation from 1914 onwards, first as one- or two-year seedling plants in the greenhouse, and secondly as older, flowering plants transferred to the experimental hop-garden at the College, where they were grown strictly according to the practice usual in a commercial hop-garden. In the open, natural infection was relied upon to determine the degree of resistance shown by mature plants, a method which proved satisfactory. Mildew was present generally in the garden from 1916 to 1920, and in a particularly severe form in 1916, 1919, and 1920. Five out of the 27 seedlings which were persistently immune under greenhouse conditions retained this immunity in the open, but it is probable that even these five would have shown a slight degree of susceptibility under particular weather or growth conditions. As the majority of the seedlings which proved completely immune in the greenhouse also

showed considerable resistance in the open, the author suggests that the term 'commercially resistant' can be applied to them. But it must not be assumed that immunity in the greenhouse is infallibly indicative of like immunity or even commercial resistance in the open, for a few of the strains have proved to be not commercially resistant when taken outside. Nevertheless, there is the most convincing evidence that the distinctive characters in regard to immunity are inherent and constitutional; they are not modified by changing conditions of cultivation or the like, and the behaviour in any one season is reproduced with scarcely any variation in other seasons. As an illustration, the case of a seedling may be cited which was planted out in the hop-garden in 1914, and successfully withstood the attempts at infection either through inoculation or by natural means. Although its immediate neighbours were severely attacked by mildew and one of them had its crop of hops totally destroyed by it in 1918, the plant in question remained untouched until, in 1919, at the beginning of August, after a spell of abnormally dull, cold weather, a few small patches of the disease were found on some of the young leaves. All traces of mildew disappeared, however, with the return of normal, i.e. hot and sunny, weather conditions. In October it was still free, though intertwined with a mildewed plant. At the end of August, 1920, notwithstanding the fact that the plant was close to two varieties so severely attacked that all their hops were destroyed, no sign of mildew could be detected on its leaves or hops. When examined again in October, the leaves were free but a trace of the disease was noted on the hops, chiefly at the tips.

Passing on to the plants that showed 'semi-immunity' in the greenhouse the records indicate that, planted out in the open, two seedlings have varied in susceptibility from 'immune' to 'slightly susceptible', while a third has exhibited the latter grade consistently. These three strains may therefore be classed as 'commercially resistant', while the remaining four are only just outside this category.

The author finally analyses the separate records of the two sexes of the seedlings, of which 189 proved to be male and 291 female. The latter showed the higher degree of susceptibility with a 'highly susceptible' percentage of 56·70 (including a large proportion of totally destructive cases). This compares with 24·34 per cent. in the males, and here no case of complete loss of crop has to be included, while on the other hand the male group produced six absolutely immune plants. But the author thinks it unsafe to consider this a proof of the greater lack of resistance in the female plant, owing to the fact that observations as to the incidence of the disease were generally made at a period peculiarly favourable to infection in this group. Both sexes would have to undergo the tests at a time when each could provide the same amount of infectible material, i.e. the male and female inflorescences, young hops. and leaves of the axillary side-shoots, in order to settle the question of the degree of resistance possessed by each. At any rate it is of interest to note the fact that of the 27 seedlings showing immunity in the greenhouse, 14 were female and 13 male.